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Field-based gravel fluxes measurements in a wandering river to assess sediment mobility downstream a dam (Durance River, Southern French Alps)

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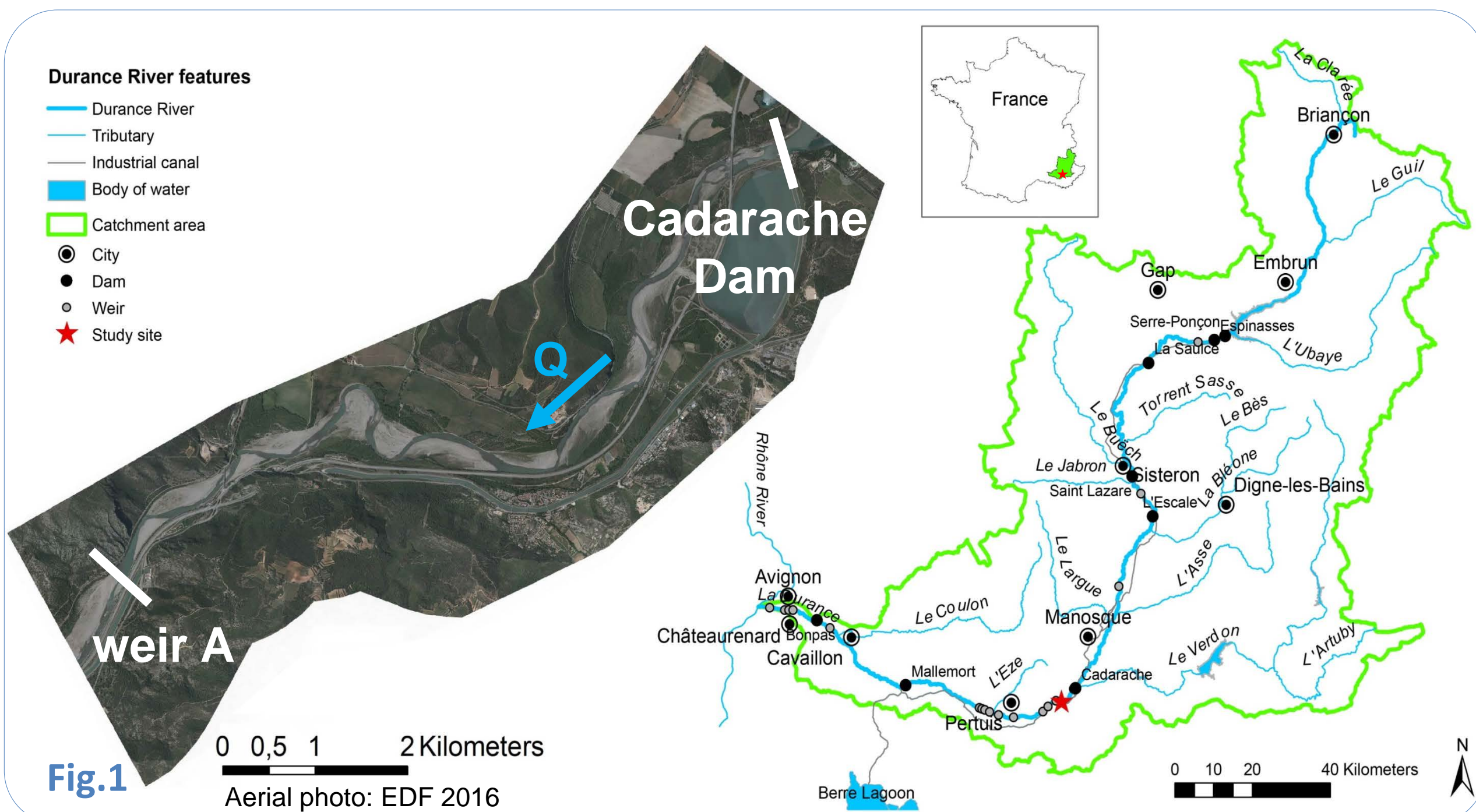
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1. Context

The Durance River is a dynamic, wandering gravel-bed river which sediment dynamics has been heavily modified in the last century because of dam infrastructures and gravel mining.



2. Aim

To study the morphodynamics of a wandering reach located downstream a dam that lets sediment go through, we:

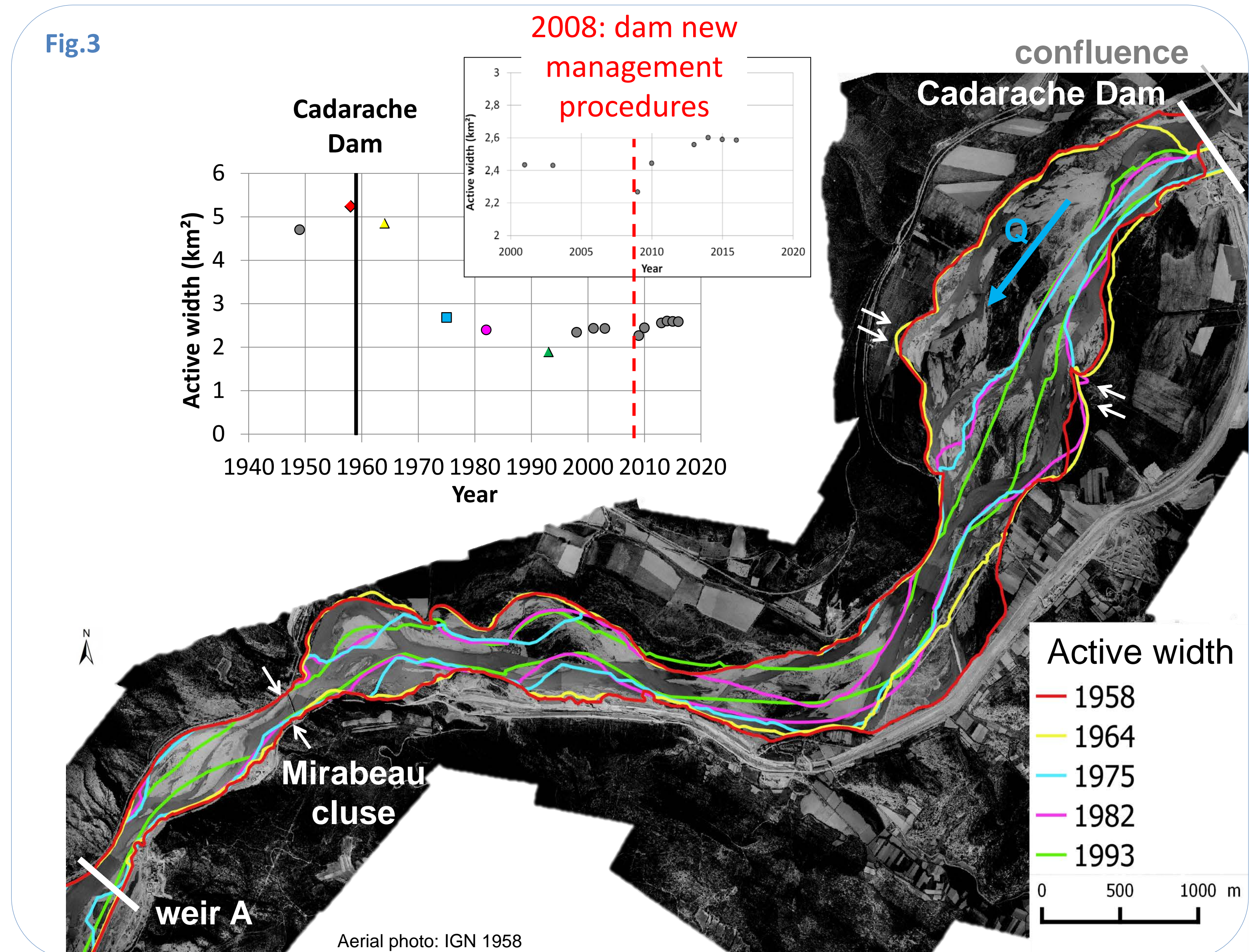
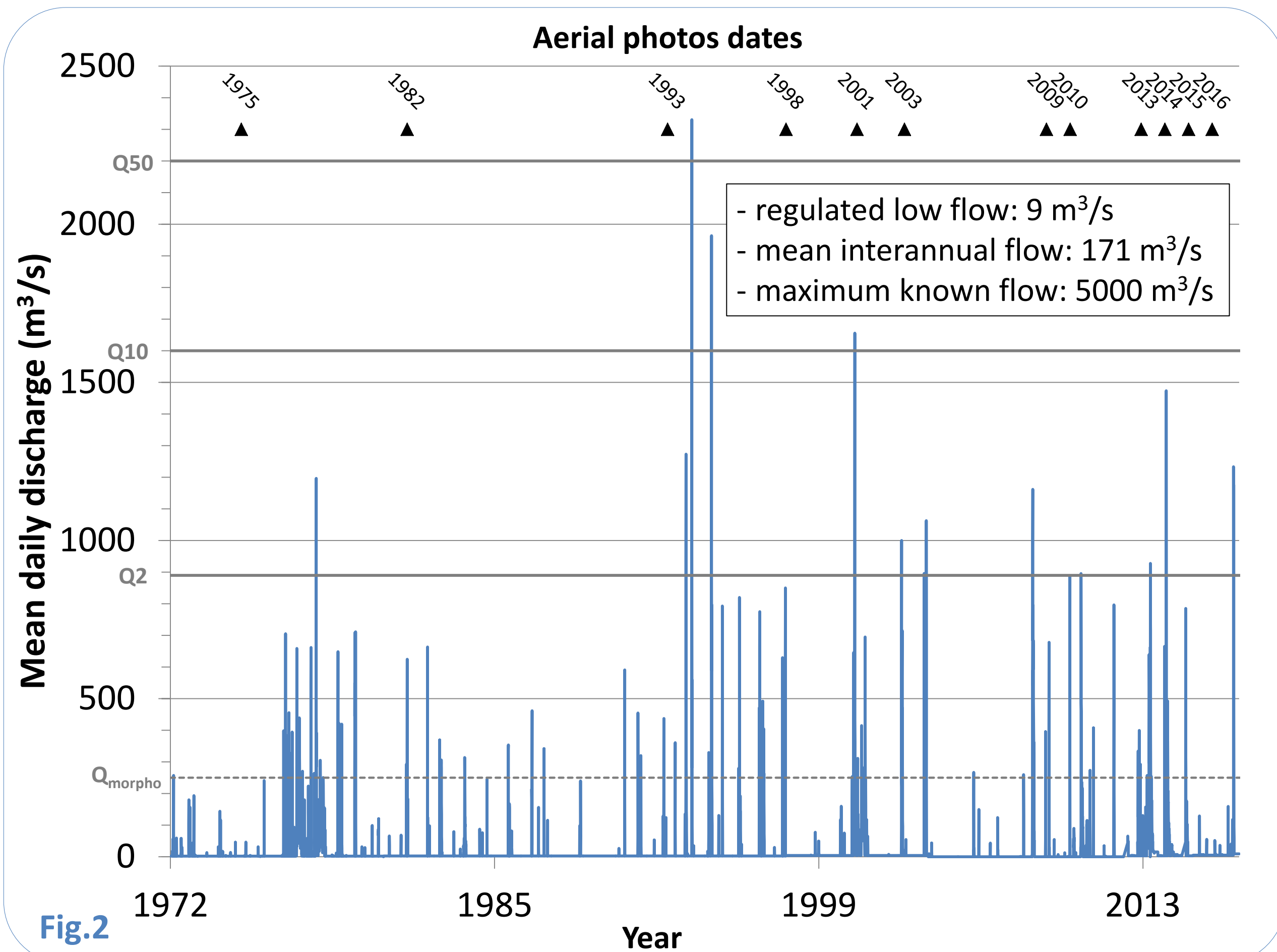
- assessed the bed morphodynamics in relation to the modified hydrology downstream the dam (study period: 1949–2016, quantification of the active width)
- quantified the mid-term (7 years: 2010–2017) sediment fluxes downstream the dam.

3. Methods

| Criteria | Objectives | Methods |
|---------------------------------|---|--|
| Active width | Spatial and temporal variability of the active width: quantification of lateral mobility and influence of hydrology | Diachronic study of orthophotographies (15 sets within 1949–2016) by active width GIS digitization |
| River bed topography | Evolution of the riverbed topography to quantify sediment fluxes | Field measurements (GPS RTK) and GIS post-processing (QGIS): DEM analyses |
| Sediment particle displacements | To quantify sediment fluxes | RFID tracking of the coarse fraction of bed material |

4. Study site – Fig.1 & Fig.2

- Large (mean width: 240 m) and steep (mean slope: 0.23%) wandering river
- 10 km-long reach located in the lower part of the Durance River (Southern French Alps), downstream Cadarache Dam
- Intense planning within the floodplain since 1960 (dam, highway, diversion canal)
- Peculiar hydrological regime: both Mediterranean and alpine influences → intense and short floods
- Bed material: gravel and fine matrix (coarse fraction: $D_{50} = 40$ mm ; sand and silt fraction: $D_{50} = 33$ μ m)
- Since 2008, new management procedures at the dam: sediment transport is allowed when flooding above 500 m^3/s → sediment continuity



5. Results

5a. Active width and lateral mobility – Fig.3

Before dam (1958)

- Lateral mobility controlled by geologic structure (confluence, cluse)

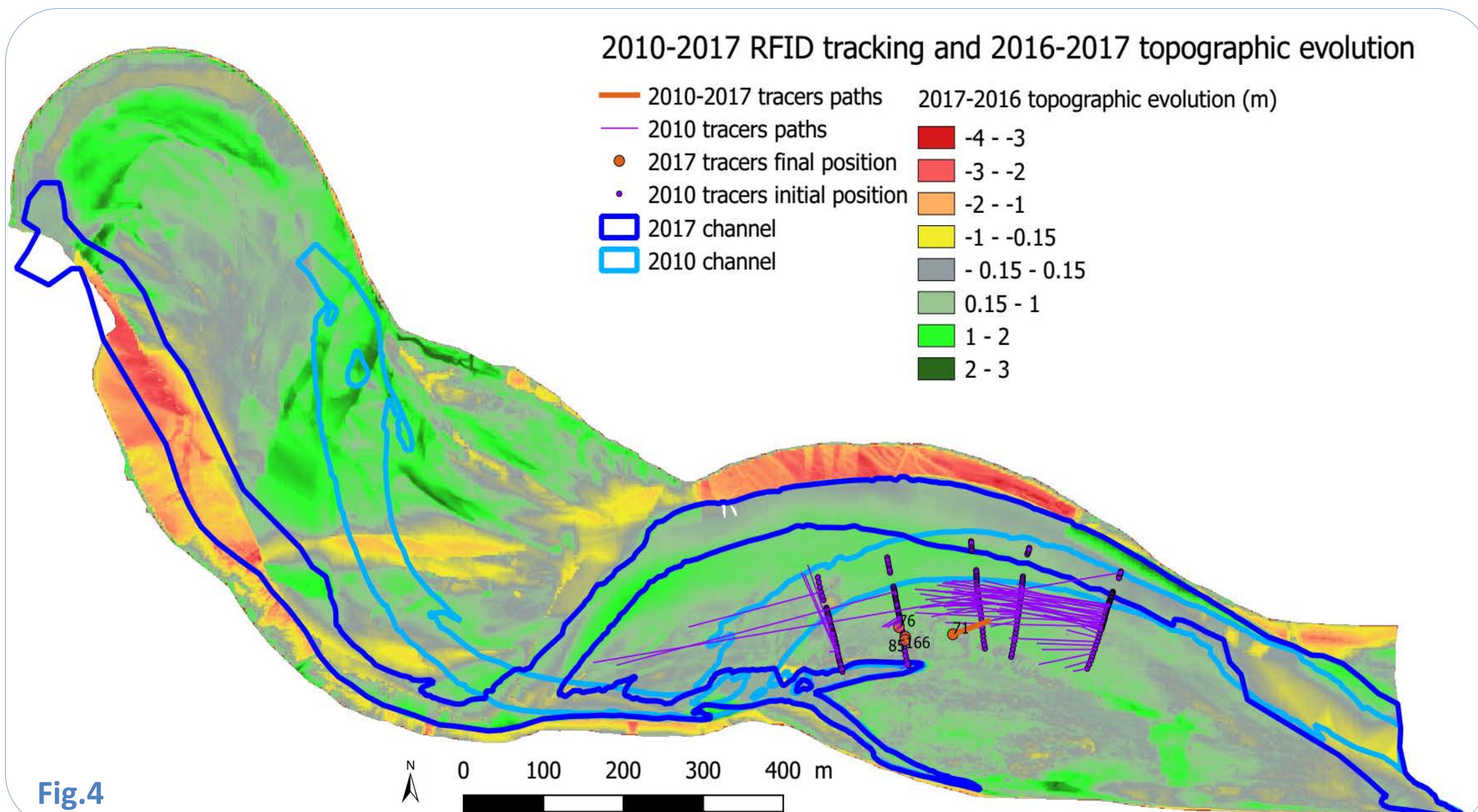
After dam (after 1959)

- 1958–1993: reduction of active width (64%), also linked to low hydrological regime
- 1994–2016: **increase in active width (11%)**, linked to:
 - intense hydrological regime (9 floods > 900 m^3/s)
 - new dam management procedures (discharge and sediment continuity)

5b. Bed topographic evolution and RFID tracking – Fig.4

2009–2017 period

- Bed reworking (erosion vs. deposition phases) linked to hydrology
- Local general trend: deposition
- Outer banks translations by bank erosion → \equiv **sediment input downstream**



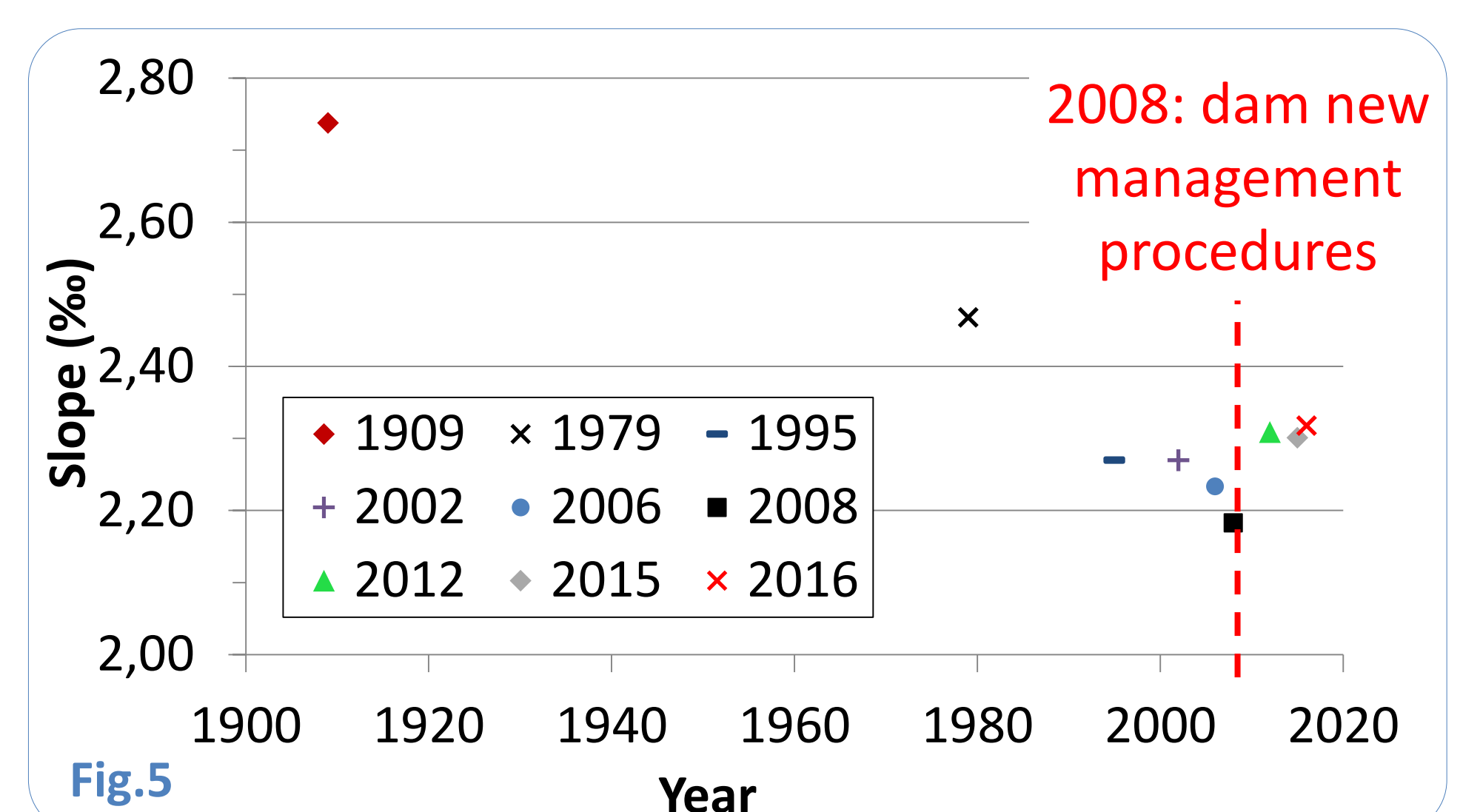
5c. Longitudinal profile – Fig.5

1909–2008 period

- Direct consequence of the dam: incision up to 2 m (Chapuis *et al.*, 2015)
- Decrease in bed slope: adjustment to sediment discontinuity due to the dam (downstream erosion)

2008–2016 period

- Increase in bed slope to adjust from dam new management procedures: validation of the « equilibrium slope » to match transport capacity and upstream bedload supply (see hypothesis in Lefort, 2007, p.13) → **reactivation of sediment dynamics**



References