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Geomorphological adjustments of the middle Garonne River downstream of Toulouse (South-West, France) since the 1950s under the effect of in-stream gravel mining

Ajustements géomorphologiques de la moyenne Garonne en aval de Toulouse (sud-ouest, France) depuis les années 1950 sous l'effet des extractions de granulats

Background

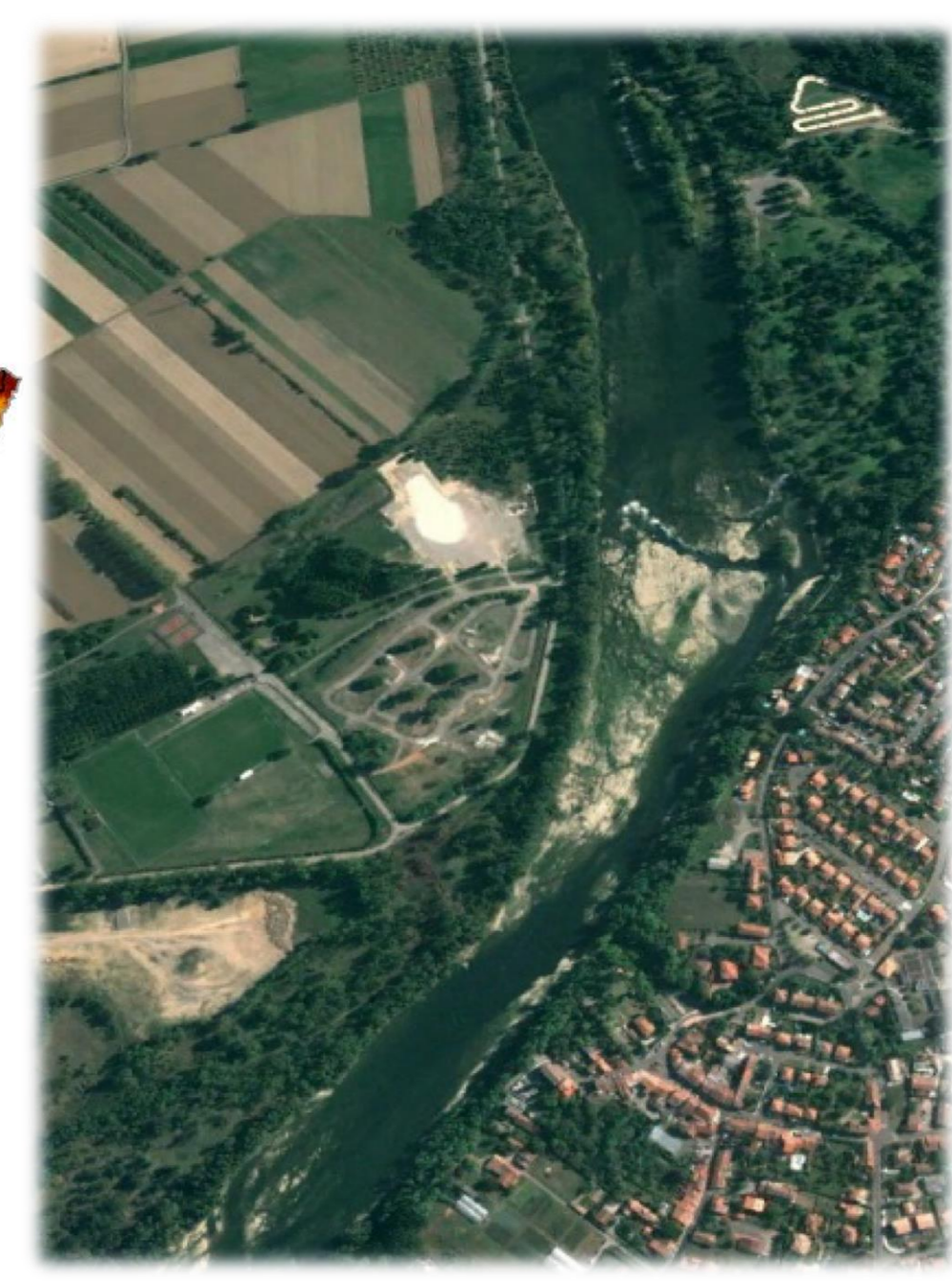
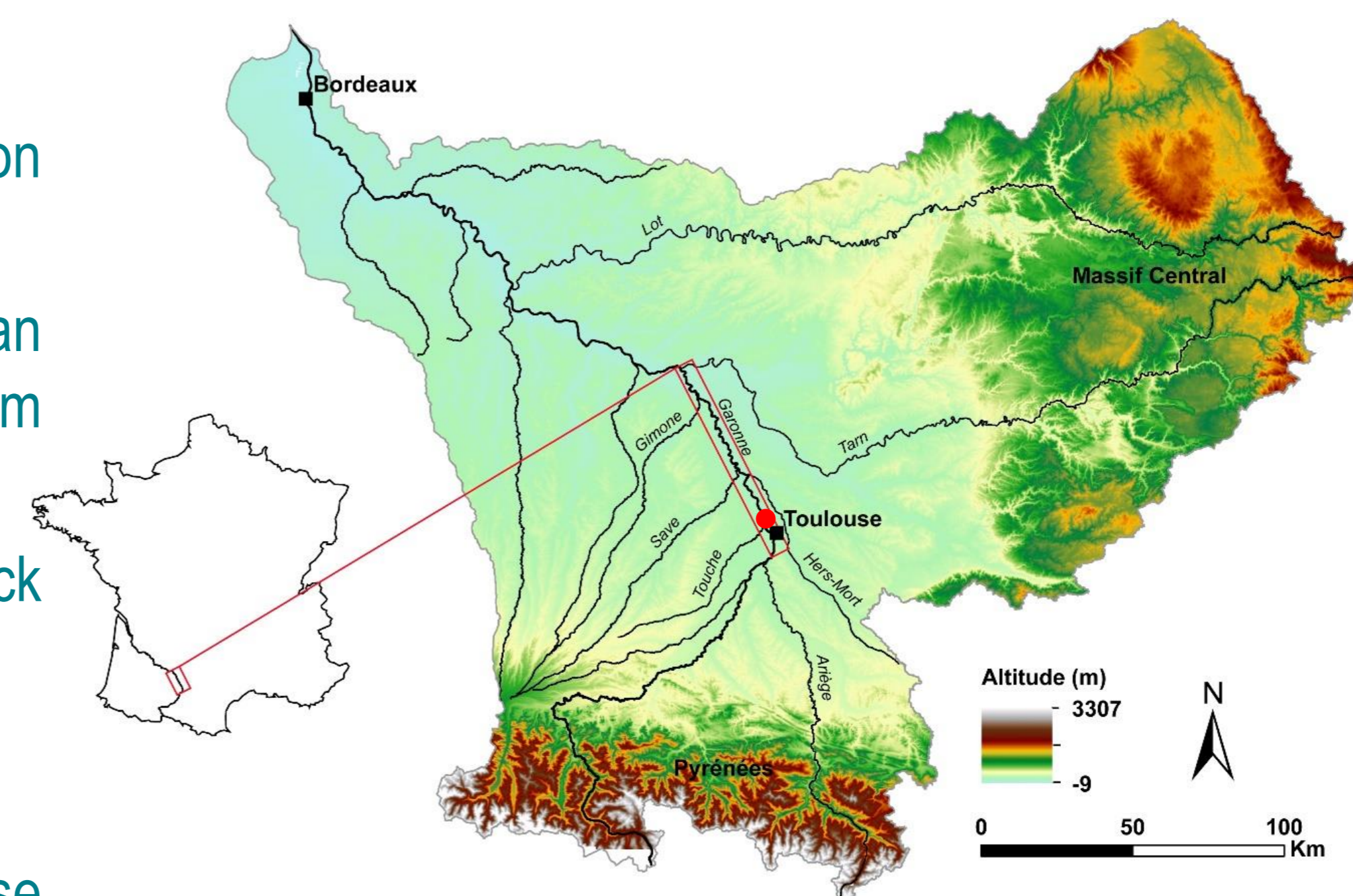
- During the 20th century, significant geomorphological adjustments are observed on the Garonne river leading to channel narrowing (-60 m) and incision (-1,7 m).
- It occurred especially from the 1950s as a consequence of intensive human interventions, such as dam construction, channel works and mainly by in-stream gravel mining with 20 M.m⁻³ extracted in 20 years.
- Nowadays the river presents a significant sediment deficit resulting in bedrock outcrops over 51% of the total channel surface.

Study site

- The study reach is located on the Garonne River, 10 km downstream of Toulouse at the town of Beauzelle.
- Width: 130 m ; slope: 20% ; stream power: 400 W.m⁻².

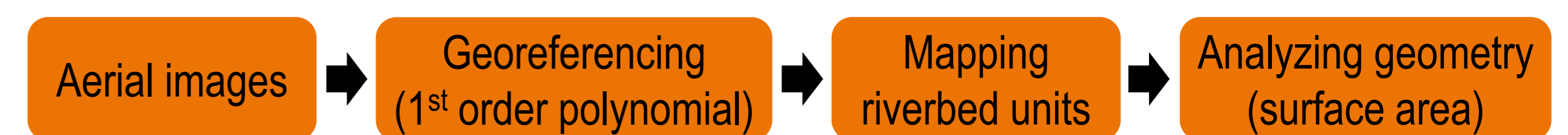
Objectives

- Identify the geomorphological changes occurring in the study reach under the effect of in-stream gravel mining during the 2nd half of the 20th century.
- Quantify the riverbed degradation.
- Highlight the transition processes between alluvial channel and bedrock channel.



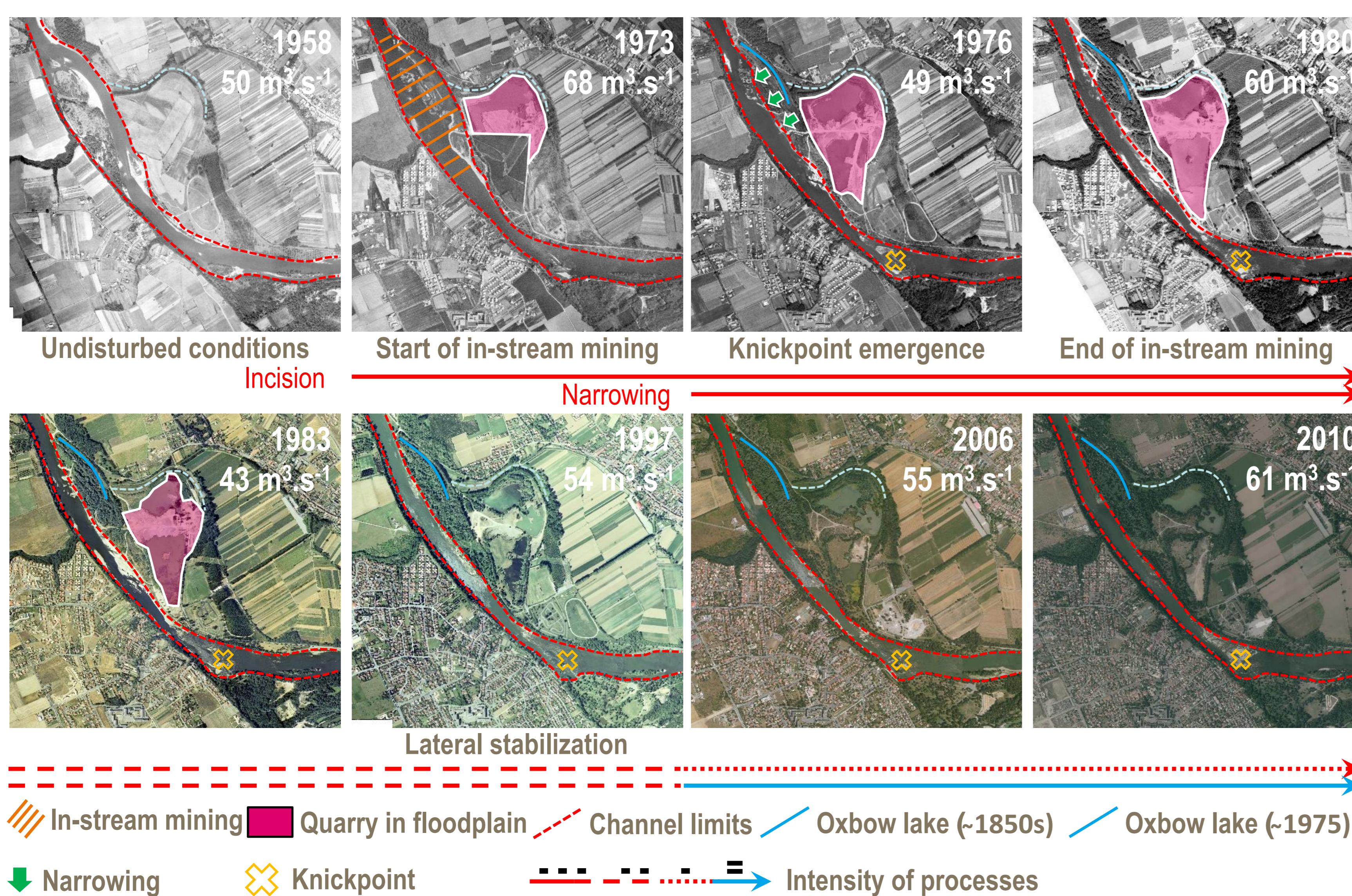
Methods

- Spatial analysis from aerial images:



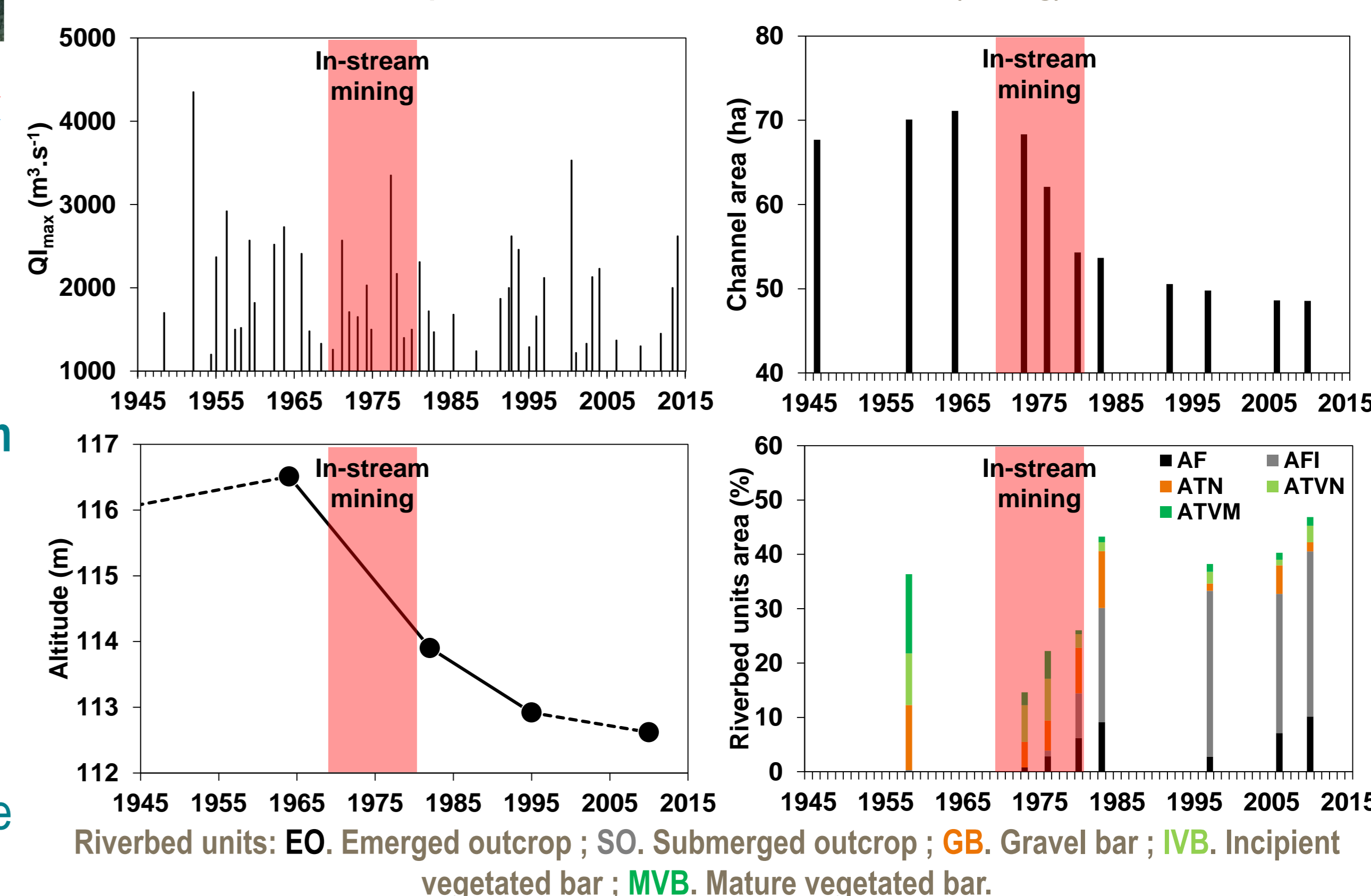
- Topographic data analysis from cross profiles.
- Hydrological data analysis based on flood records.

Changes in channel morphology



Process of incision

- In-stream gravel mining with 389 000 m³ extracted over the 1970s according to archive sources.
- In response, the channel experiments:
 - 1) bed channel load removal,
 - 2) erosional regression estimated at ~27 m.an⁻¹ leading to a gas line rupture (1982) 300 m upstream of the extraction site.



Channel degradation and simplification

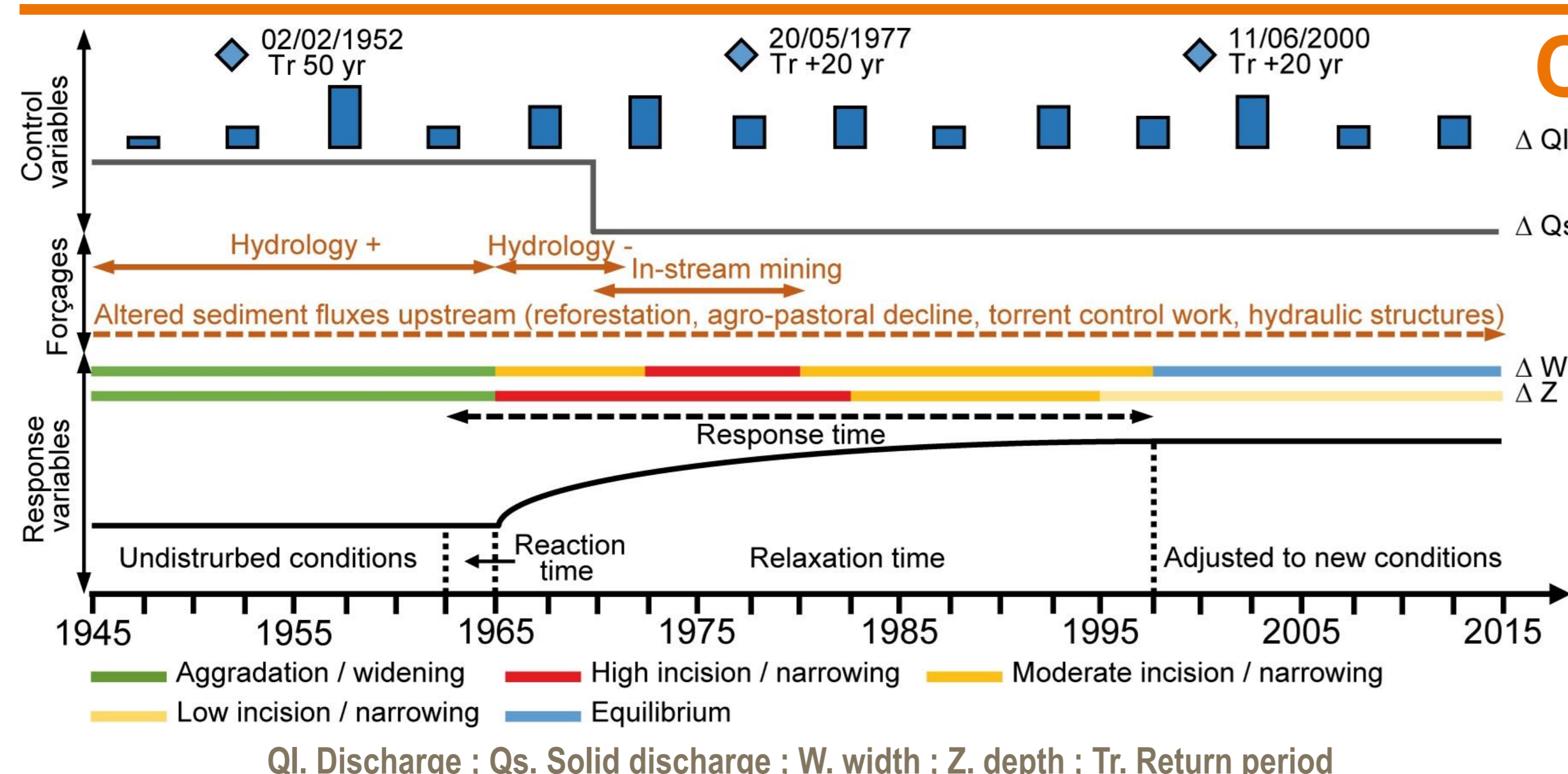
- Significant narrowing and incision is recorded between 1960s and 1990s with a maximum intensity over 1970s corresponding to the period of in-stream mining:

	1960s-1990s	1970s
Narrowing :	-61 m / -1,3 m.an ⁻¹	-38 m / -4,7 m.an ⁻¹
Incision :	-3,6 m / -11 cm.an ⁻¹	-2,7 m / -14 cm.an ⁻¹

- Between 1958-2010 channel morphology experiments drastic changes with 41% increase in outcrops and 10%-15% decrease in gravel and vegetated bars.

Conclusion

- This study highlights the role of in-stream mining as the dominant factor in channel degradation at the local scale.
- In-stream mining and lack of sediment connectivity resulted in an incision greater than 4 m and a high sediment deficit.
- Change of incision process from evacuation of alluvial cover by regressive erosion and gradual outcropping of the bedrock to erosion of this latter.
- Appearance of a knickpoint of more than 3 ha with 3 m difference in height.



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