

Prioritisation of river sections for restoration based on evidence of geomorphological adjustments (Saja River, Spain)

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1. INTRODUCTION

The Saja River, one of the last multi-thread rivers in northern Spain, has narrowed and simplified since the mid-20th century due to forest expansion and human interventions reducing sediment supply, threatening its ecological diversity. This study analyses a 30 km reach divided into 10 sections to prioritise restoration using geomorphological indicators (Figure 1).

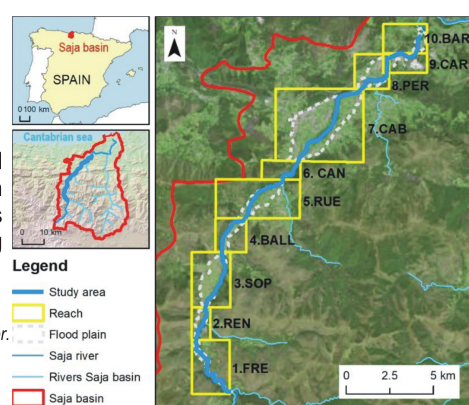


Figure 1. Study area of 30 km of the middle course of the Saja River.

2. METHODOLOGY

An evolutionary geomorphological analysis (1957–2024) combined aerial photos, terrain models (2009–2024), drone imagery, and field surveys to assess channel narrowing, artificial impacts, lateral erosion, and vertical incision. Sections were scored for imbalance and recovery potential, and classified into priority levels (Table 1).

TOTAL POINTS	PRIORITY
0-40	Low
41-90	Medium
>91	High

Table 1. Priority ranges

3. RESULTS

Since 1957, the Saja River has narrowed by 31%, with 12% of sites showing active bank erosion and 43 points with vertical instability (Figure 2). Sectors 3 and 5 have lost the most active channel area (31% and 28%), while sectors 7, 9, and 8 are most affected by artificial interventions (37%, 33%, 28%)(Figure 3). Vertical incision is most severe in sectors 10 and 2, reaching up to 2 metres in sectors 2, 3, 7, and 10. Erosive banks are common in sectors 3, 4, and 7. Considering morphodynamic conditions, sectors 3, 10, and 7 are top priorities for restoration due to their severe imbalance and recovery potential (Table 2).



Figure 2.Examples of field evidence: bank erosion and incision in the Saja River.

REACH	%NAR	%ART	%ERO	INC	H	TOTAL
1.Fre	0	0	10	0	5	15
2. Ren	10	5	30	10	10	65
3. Sop	50	20	50	0	10	130
4. Ball	10	5	50	5	0	70
5. Rue	50	5	10	5	5	75
6. Can	0	0	0	5	0	5
7. Cab	10	40	30	5	10	95
8. Per	30	40	10	5	0	85
9. Car	0	40	0	5	0	45
10. Bar	30	0	30	30	10	100

Table 2. Results obtained by section.

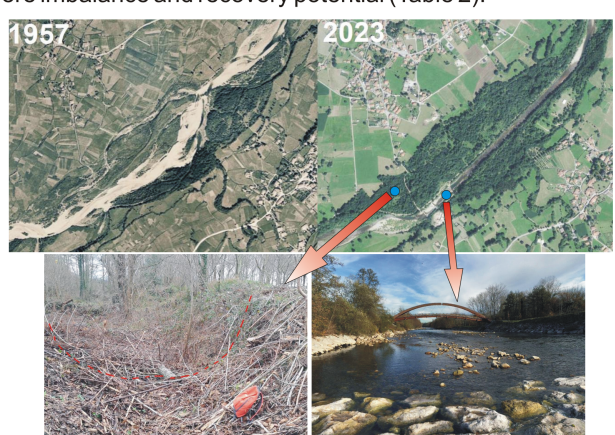


Figure 3. Evidence of secondary channel loss and river channelisation in the Saja River

4. CONCLUSIONS

Since the 1950s, the Saja River has suffered incision, channel loss, riparian fragmentation, and bank instability due to land use changes and bank protection. This study prioritises sections for restoration using a triage method based on morphodynamic conditions: three high, five medium, and two low priority. For effective actions, results should be complemented with biological and socio-economic factors (González del Tánago & García de Jalón, 2017).

REFERENCES

González del Tánago, M. y García de Jalón, D. 2017. Estrategia de restauración de ríos de la Comunidad de Madrid: Diseño metodológico. Informe Técnico, 78 pp. Universidad Politécnica de Madrid.

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