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CONTROLS ON INITIAL OXBOW SEDIMENTATION AS OBSERVED WITHIN RECENTLY CUT-OFF CHANNELS OF THE AIN RIVER, FRANCE

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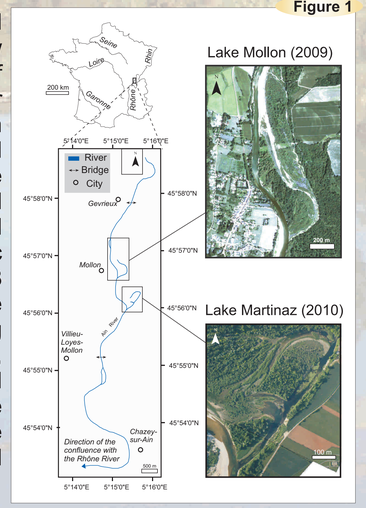
1 Introduction

Oxbow lakes are one of the most common water features observable along the floodplains of meandering rivers. They are typically crescent-shaped, forming from an abandoned meander after a river cuts-off to form a new channel. Oxbows tend to progressively aggrade with sediment until complete terrestrialisation, and it can take between 10 to >1000 years. Just after cut-off, the abandoned channel is aggraded by bed material, which forms a plug that disconnects the upstream (and sometimes downstream) entrance from the old channel[1,2]. Understanding the development of sediment plugs is important for determining the longevity of oxbows as aquatic habitat because plugs prevent further bed-material deposition and are pivotal to establishing the initial open-water volume.

2 Aim of the study

Figure 1

Our study aims to understand the initial aggradation of oxbow lakes using two recently cut-off channels of the Ain River (France). These sites cut-off in 1994 (Mollon, fig.1), 2002 and 2003 (Martinaz, fig.1). The growth of the bed-material plugs have been well documented with topographic data from 1999, 2004, 2008 and 2010, which makes these sites very suitable for studying plug formation. In addition, because of their proximity and their similar age, they have undergone comparable hydraulic and sedimentological histories.



3 Methodology

The first stage of cut-off channel aggradation has been investigated with:

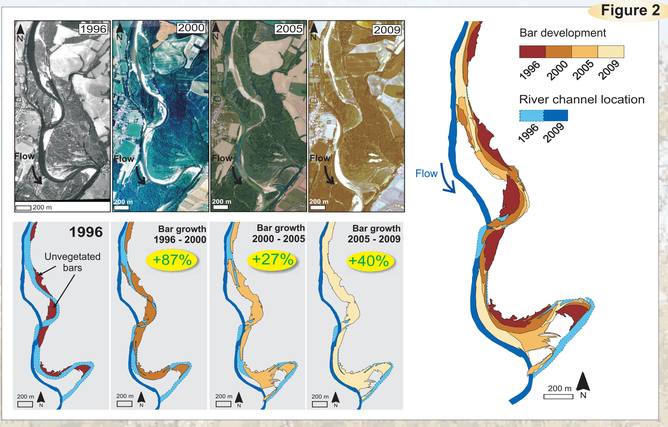
- aerial photographs from 1996 to 2010 georectified using GIS
- a longitudinal profile measured in 1999 (before plug blockage)
- cross sections from 2004 (after blockage)
- LiDAR from 2008
- Differential-GPS field survey from 2010.

4 Result A: Repartition of the initial deposition

- Mollon oxbow lake (upstream, fig.1 and 2) was cut-off around 1994 and Martinaz (downstream) cut-off in 2002 and 2005. Mollon have an initial diversion angle of 15° whereas it was 40° and 80° for Martinaz double cuts-off.

- The terrestrialization of Mollon has mainly occurred by the development of bars within the channel whereas Martinaz was aggraded exclusively on its upstream entrance (see 2000-2005, fig.2)

Figure 2



5 Result B: Quantification of sediment deposits

References Location

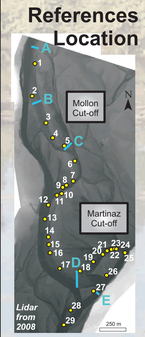


Figure 3

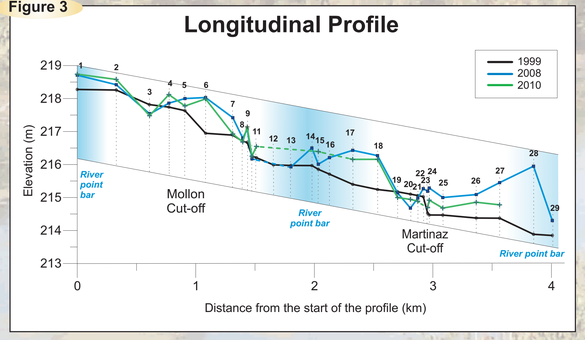
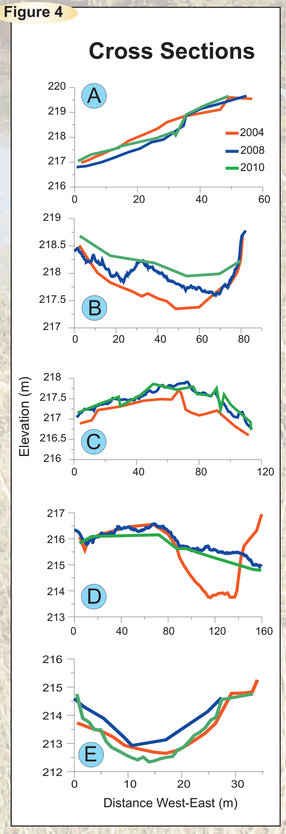


Figure 4



➤ MOLLON CUT-OFF *(fig.3 ref.2 to 11, fig.4B,C)*:

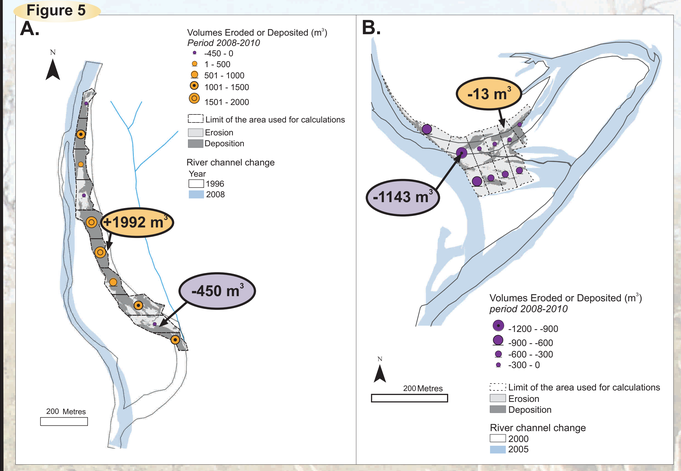
- Sediment deposition between 1999 and 2010 was highest in the middle of the former channel *(point 6, fig.3)*. Although the entrance may have eroded by 30 cm *(point 3, fig.3)*, much of the former channel experienced significant aggradation, up to 1.2 m between 1999 and 2008.
- Even after plug formation in 2005, the entrance continued to be aggraded by up to 75 cm by 2010 *(fig.4B)*. The rate of aggradation systematically decreased downstream of the entrance (50cm max, *fig.4c*).

➤ MARTINAZ CUT-OFF *(fig.3 ref.18 to 27 and fig.4D,E)*:

- The longitudinal profile shows that since 1999, up to 1 m of sediment deposited at the upstream and the downstream entrances of the former channel *(ref 18 and 26 fig.3)*. Almost 2 m of sediment was deposited locally within the upstream plug between 2004 and 2008 *(fig.4D)*.
- However, the downstream part of the former channel was eroded by 30 cm between 2004 and 2008 (last cut-off happened in 2005). Later, between 2008 and 2010, 50 cm of sediment was deposited downstream *(fig.4E)*.

6 Result C: Post Plug formation

Figure 5



- Once the plug is fully developed upstream, direct bed-material transport is obstructed at the entrance of the former channel. Figure 5 shows a 2 year sediment budget (2008-2010) of the terrestrial part of the oxbows, indicating how the sediment plugs evolved after their formation.

- The volumetic change in sediment being stored/eroded between 2008 and 2010 is approximately 7500 m^3 for Mollon and -4000 m^3 for Martinaz.

- The largest deposits in Mollon are located on the upstream part of the cut-off. Most of Martinaz erosion occured in the area on the concave bank of the new river channel, and a sediment deficit downstream of the Mollon cut-off could have accentuated the erosion within Martinaz.

7 CONCLUSION

➤ The initial sediment aggradation can vary: by growth of the bars or by aggradation on the upstream end.

The location of the cut-off on the meander bend are different (convex vs concave) and this, along with the diversion angle[3,4], have probably affected the initial bed-material transport within the former channels.

➤ After the plug is fully developed the dominant process is not necessarily sedimentation.

Sediments carry on being remobilized within former channels and the channel shape favoured the erosion of the plug at Martinaz.

➤ The shape of the new channel is an important control.

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