

# Morphosedimentary features from a major flood on a small, lower-sinuosity, single-thread river: The unknown quantity of overbank deposition, historical-change context, and comparisons with a multichannel river



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## ABSTRACT

This study details overbank sedimentation on a single-thread, bedload stream, the Little Blue River (southeastern Nebraska and northeastern Kansas, USA), which experienced exceptional floods during May–June 2015. Downvalley elongate *splays* left deposits as thick as 1.2 m and attained areas as great as 156 ha. Splays consisted of fields of large, gravel-covered dunes 0.1 to 0.3 m in height and extensive sand sheets with current ripples or current ripples atop low-relief, long-wavelength dunes. Erosion occurred chiefly in the heads of splays. *Levee-floodplain channel complexes* were more architecturally complicated, with channel–channel-fringing deposits deposited within ~110 m of the banks of the channel. These complexes consisted of two amalgamated components: (1) sediment shadows (vegetation-induced sedimentary structures), as long as 6 m and as high as 0.6 m at their heads, which were produced by the interaction of direct overbank flow with rooted trees; and (2) indistinct, flat-topped bars (some of which were built around eroded remnants of sediment shadows) shaped chiefly by downvalley flood flow. Changes on in-channel bars, the erosion of bank crevasses as large as 70 m in width, and the deposition of large woody debris also occurred during the floods.

The earliest aerial photographs (1938) of the study area, taken after multiple low-flow years, show no evidence for recent overbank deposition. Increases in channel-belt area, the number of bars, and the sizes of bars in the Little Blue River took place after 1938, and most rapidly during 1938 to 1950, when annual discharge was increasing. Annual discharge has decreased since ca. 1990, and yet there has been a long-term increase in annual peak flow since the 1930s. We surmise that increasing annual peak flows have led to larger floods and, since 1938, serial overbank deposition, as well a wider channel and numerous, large compound bars.

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## 1. Introduction

Overbank (splay and natural levee) deposits on small modern streams have rarely been described in great detail, much less interpreted within the context of specific events (e.g., Ritter, 1975, 1988; O'Brien and Wells, 1986; Bristow et al., 1999; Garzón and Alonso, 2002; Ito et al., 2011; also, a series of papers that discuss the same fluvial system: Cazanagli and Smith, 1998; Adams et al., 2004; Smith and Pérez-Arlucea, 2008). Detailed published descriptions of crevasse splays and natural levees in large, extant river systems are also surprisingly few in number (e.g., Farrell, 1987; Gomez et al., 1997;

Jacobson and Oberg, 1997; Gębica and Sokołowski, 2001; van Dinter and Zilverden, 2010; Arnaud-Fassetta, 2013; Day et al., 2016). Thus, it is likely that more is known—or presumed to be known—about the ancient sedimentary record of floodplain deposits than about modern floodplain sediments (Jorgensen and Fielding, 1996).

Floods on the Little Blue River in southeastern Nebraska and northeastern Kansas, USA (Fig. 1A, B), during May and June 2015 (Fig. 2A) included one of its largest annual peak flows ever, despite an overall decline in discharge since ca. 1990 (Figs. 1, 2; Table 1). The floods of 2015 left extensive overbank deposits, which are only rarely observable along rivers near the eastern margin of the Great Plains due to factors such as the infrequency of flooding, stream entrenchment, and dam construction (e.g., Smith et al., 2014). Overbank deposits have hitherto been an unknown quantity on the Little Blue River because they are rapidly removed by agricultural activities, precluding scientific investigations and

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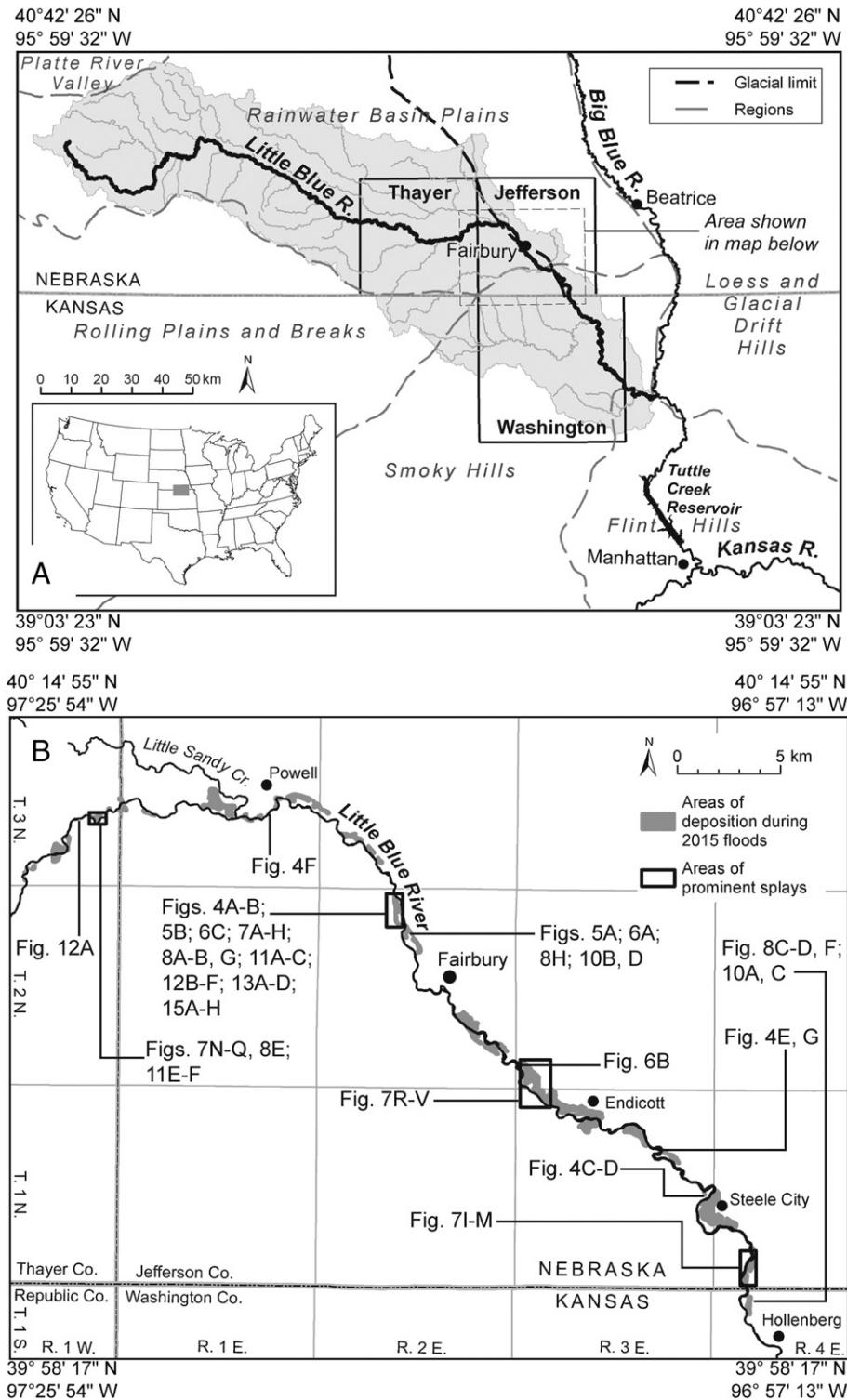


Fig. 1. (A) Location of basin of Little Blue River in Nebraska and Kansas, USA. (B) Study area with locations of figures indicated.

fostering an incorrect perception of regional fluvial sedimentology. Nevertheless, the 2015 floods and widespread overbank deposition can be seen as a post-1938 pattern of fluvial-system change on the Little Blue River that includes increases in annual peak flows, channel width, and the numbers and sizes of compound bars. This study describes the 2015 overbank deposits on the single-thread Little Blue River, places them in a historical context of system change, and compares them with those of the braided to anabranching South Platte and upper Platte rivers South Platte and upper Platte rivers (Joeckel et al., 2015).

## 2. Setting

The Little Blue River is a tributary of the Big Blue River, which flows southwards through southeastern Nebraska to join the Kansas River in northeastern Kansas (Fig. 1A). The latter flows eastwards into the Missouri River, one of the largest river systems in North America. The Little Blue River has not been impounded, but the Big Blue River has since the 1960s. The headwaters of Tuttle Creek Reservoir in Kansas (Fig. 1A) extend upstream on the Big Blue River to a point ~35 km

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