Decreased Floodwater Storage Capacity due to Historical Sediment Accretion and Channel Straightening: South Fork of the Iowa River

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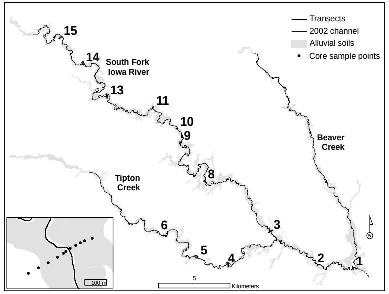
Objective: To determine how of post-settlement alluvium (PSA) and channel straightening affect this river valley's flood storage capacity.

Location map:

Materials and Methods

Field work--selected 15 transects across the valley, collected soil cores (Max depth 8 ft) and surveyed core-sample points with GPS.
Lab work--described, photographed, and determined PSA thickness and extent. Determined bulk densities.

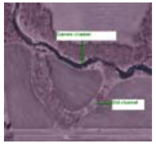
Position of core-sample transects



Map analysis-- Evaluate changes in the stream course during recent decades.

Tipton creek

South fork Iowa River



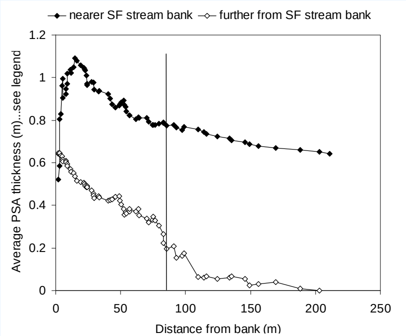
Beaver creek

Digitized stream courses for the 1930s and 2002 calculated channel metrics and quantified stream movement (area of stream migration)

Results and Discussion :

Field study of PSA   94 points were core-sampled , PSA was observed in 67 of these, and was 2.5 to 173 cm (1 to 68 in) thick. PSA (typically loams and sandy loams) mean depth and frequency of occurrence were plotted with increasing / decreasing distance to stream bank (Fig. 1). Multiplying channel lengths by PSA width and depth, we estimate total volume and mass of PSA decreased floodplain water storage capacity by 4123 acre-feet, which equates to 11.3 mm (0.44 in) of runoff.

FIG. 1 Data are shown for the South Fork (SF) River only. Within 80 m of the stream, PSA frequency was 85% with an average thickness of 0.78 m. Beyond 80 m, PSA frequency decreased to <50%.



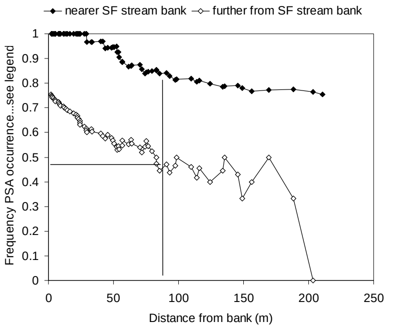


Table.1 Channel lengths, sinuosities, and fractal dimensions of South Fork Iowa River and major tributaries in 1930s and 2002.

Year	*Tipton Creek*	*South Fork*	*Beaver Creek*
		Length, m	
1930	32935	64868	28168
2002	27880	60196	23668
decrease	5055	4672	4500
		Sinuosity, m m^{-1}	
1930	2.44	2.34	1.76
2002	2.02	2.20	1.47
		Fractal Dimension	
1930	1.135	1.118	1.070
2002	1.088	1.091	1.047

Map analysis of channel movement   Between the 1930s and 2002, there was a clear reduction in channel length for TC, SF, and BC (Table 1) , the loss of sinuosity was dominantly due to stream straightening by evaluating map polygons of areas between where the stream was positioned in 1930 and in 2002 (Table 2, Fig. 2) Channel storage was decreased by an estimated 163 acre-ft by straightening.

Table 2. Numbers and total area of stream migration polygons delineated by overlaying stream courses digitized from 1930s-era and 2002 aerial photography. Meander and straight classes were manually interpreted and show the proportion of stream migration due to natural meandering and stream straightening.

Polygon lass	*No. polygons*			*Area of polygons*		
	SF	TC	BC	SF	TC	BC
		(count)			(ha)	
Meander	269	159	103	72.3	22.2	13.5
Straight	73	65	101	33.0	21.8	28.9
Unknown	190	64	76	10.7	2.7	2.7
Total	532	288	280	116.0	46.7	45.1

Fig 2

Tipton creek   South fork Iowa River   Beaver creek

Discussion   Between PSA and lost channel storage, the channels and floodplains of SF and TC have decreased water storage capacities by 5.29 x 106 m3 (4285 ac ft). This volume of decreased storage capacity would probably have their greatest impact during small and intermediate flood events; while this volume loss represents about 8.8 hours of the peak daily discharge observed during the 2008 floods, it represents nearly 26 hours of the largest daily discharge observed in SF record between 1995 and 2007.

Conclusions:

- Recent sediment has been estimated removed a volume of storage capacity equivalent to 11.3 mm (0.44 in) of runoff from the entire watershed, and represents 156.6 Mg ha^{-1} (69.8 t ac^{-1}) of soil lost from the watershed's uplands.
- This soil loss was generated from agricultural fields in a watershed with low relief and subsurface drainage, which has a relatively short history of settlement (since the 1850s).
- The impact of PSA and geomorphic responses to this sediment accretion need to be considered in planning and implementation of river restoration projects.