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Landscape response to the intentional use of the Birds Point New Madrid Floodway on May 3, 2011

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SUMMARY

During the spring of 2011 massive, coalescing storm fronts in the upper Mississippi, and Ohio River basins caused extreme weather conditions that flooded the bottleneck section of the Mississippi River in the vicinity of Cairo, IL. In order to alleviate the volume of floodwaters acting on downstream levees and to stop flooding near Cairo, IL, the US Army Corps. of Engineers activated the Birds Point New Madrid Floodway by intentionally breaching the Birds Point Levee, releasing floodwaters onto active agricultural fields. The impacts of floodwater on the landscape were regionally significant. Concentrated erosion generated deep scour holes, rills, and gullies in localized areas of the floodway. Inflow and outflow of waters formed large deposits of sands and gravels. Sand sheets of a few centimeters to a meter thick blanketed the vicinity of the impacted areas, and in some cases sand accumulations exhibited current ripples indicating multiple flow directions. This study directly addresses geomorphic changes in the New Madrid Floodway resulting from activation and the diversion of floodwaters from the Mississippi River. Results from this study can be used along with other field data to conduct a thorough flood damage assessment that includes the costs associated with geomorphic alteration within the floodway.

1. Introduction

On May 3, 2011, the United States Army Corps. of Engineers (USACE) activated the Birds Point-New Madrid Floodway to control the high flood waters of the Mississippi River intentionally breaching the levee system. Breach of the frontline levee occurred in three sections; the first and northernmost breach occurred along the 3.2 km (2 mile) fuseplug portion of the earthen Birds Point levee, located in Mississippi County, Missouri south of Cairo, IL. Two smaller detonations followed in the second fuseplug portion of the mainline levee and the inflow crevasse to the south, closer to the city of New Madrid, MO (Fig. 1). The northernmost section of the mainline levee was breached in order to protect the City of Cairo, Illinois from the high waters at confluence of the Ohio and Mississippi Rivers; and also to relieve pressure on the Paducah levee that protects a southern tributary of the Mississippi River lacking parallel levee protection.

The immediate cost of cropland inundation and destruction of personal property from floodway activation captured the attention of the media, public, and policy makers and it is these costs that are typically used to calculate flood damage assessment (Jacobson, 2003). While the economic costs of these immediate damages were assessed (Brown et al., 2011), erosion and sedimentation effects from previous flooding in the lower Mississippi River valley have been shown to be an order of magnitude more costly than a single year's crop and more persistent (Jacobson, 2003). Therefore, the success or failure of the New Madrid Floodway activation is directly related to the magnitude of its geomorphic effects, how long these effects will persist, and how they will continue act to diminish future agricultural production (Jacobson, 2003). The case study presented here reports the observed geomorphic effects in the 24 km (15 mile) radius immediately north of the Inflow/Outflow Crevasse #1 breach near Big Oak Tree State Park, east of New Madrid, MO. In addition, it analyzes remote sensing imagery for mapping of scour and sand deposits in the northernmost part of the floodway at the main levee breach and within the floodway itself. Field evidence collected as part of this study and remote sensing imagery analysis indicates that the intentional breach of the New Madrid Floodway exceeded geomorphic thresholds for landscape modification. The results of this case study can be used along with other field data to conduct a thorough flood damage assessment that includes geomorphic change within the floodway.

1.1. Background of the floodway

The Birds Point-New Madrid Floodway is a 56 km (35 mile) long, 6.4–19.2 km (4–12 mile) wide, 648 km^2 (205 square miles)

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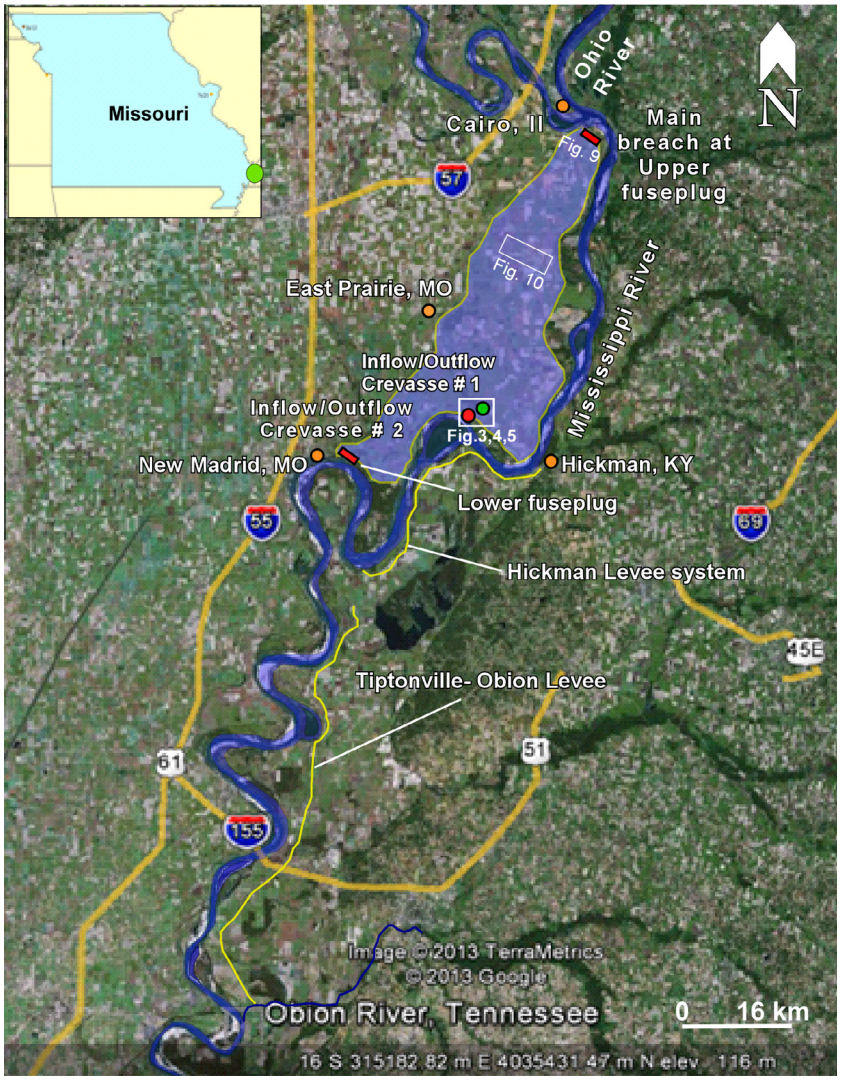

Fig. 1. Google EarthTM aerial image of the Birds Point New Madrid Floodway. The floodways is composed of a mainline levee along the main channel and the setback levee which runs parallel to channel. Both the mainline and setback levees are denoted as light yellow lines in the figure. The main breach of the fuseplug of the main section of the main levee occurred at 10:03 P.M., approximately 15 h before the second breach at Inflow/Outflow Crevasse # 1 at Big Oak State Park across the Mississippi River from Hickman, KY. The third and final breach occurred 64 h after the original breach, at the Inflow/Outflow Crevasse # 2 in New Madrid, MO. The main breach allowed initial hydrostatic relief on the Mississippi River, while the last two allowed inflow initially, and final recession of flood waters from the floodway.

alluvial valley located on the west bank of the Mississippi River below confluence of the Ohio and Mississippi Rivers in southeast Missouri (USACE, 2010; Fig. 1). The floodway functions as a shallow retention basin bounded by a front line (mainline) and back line levee, and it is designed to lower the flood crest 1.07 m (3.5 ft) when activated (USACE, 2010).

The floodway is composed of a frontline levee and setback levee (Fig. 1). The setback levee extends from Birds Point, Missouri, to New Madrid, Missouri, and serves as a northern embankment to contain floodwaters. The frontline levee was built along the west bank of the Mississippi River and typically follows the main river channel alignment. In order to accommodate hydraulic relief of the Mississippi and allow floodwaters to discharge into the floodway, two fuseplug sections approximately 0.6 m (2 ft) lower in elevation were constructed in the frontline levee (the upper and lower fuseplug). This modification of the frontline levee was performed to allow easy blasting as part of a long term flood management plan for the lower Mississippi Valley. This dates back to 1927 (MRC, 2012). The upper fuseplug section is located near Cairo, IL, where the main levee breach for hydraulic pressure dissipation occurred and was designed to protect against Mississippi River water elevations of 18.6 m (60.5 ft relative to the Cairo, IL gage). The upper fuseplug levee is approximately 17.6 km (11 miles) in length (USACE, 2010; Fig. 1), though only approximately 3.2 km of this section was breached. Located in the southernmost end of the frontline levee east of New Madrid, MO, the lower fuseplug serves as a relief for floodwater recession and measures 8 km (5 miles) in length. To allow further drainage for interior run-off and floodwater recession, a 457 m (1500 ft) gap was built at the junction of the setback and frontline levees near New Madrid, Missouri (USACE, 2010). Breach of the fuseplug levee sections occurs only in the event of a major flood, or what is termed the project flood or flood of record, diverting 15,574 cm (550,000 cubic feet per second, cfs) of water from the Mississippi River (USACE, 2010). At Cairo, the project flood is estimated at 66,828 cm (2,360,000, cfs to contain the combined discharge from Ohio and middle Mississippi rivers), 1.07 m (3.5 ft) below the top of the flood wall that protects the city (USACE, 2010). The lower third of the floodway is used as a backwater storage area (USACE, 2010; Olson and Morton, 2012a,b).