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Anthropogenic landforms and sediments from dredging and disposing sand along the Apalachicola River and its floodplain

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ABSTRACT

The Apalachicola River, which begins at the confluence of the Chattahoochee and Flint rivers near the Georgia-Florida State line, has multiple human impacts. Water inputs declined due to upstream irrigation and urbanization in Georgia. Sediment trapped by numerous small to large dams, including construction of Jim Woodruff Dam in 1954 near the Apalachicola-Chattahoochee-Flint (ACF) confluence has increased degradation. Shortly thereafter, the river was modified for a navigation project, with 29.6×10^6 m^3 dredged between 1957 and 2002 from the Apalachicola alone. This study investigates how historic dredging coincides with the modern morphology of the channel and how historic dredging, disposal, and other activities have modified the floodplain landforms and sediments. This analysis of the navigation impacts in the middle Apalachicola River (River Miles 40 to 65) ties spatial and temporal variations of dredging, field-derived bathymetry, historic maps, patterns of floodplain disposal of dredge spoil from LiDAR imagery, and modern point bar channel change of the Apalachicola River. Floodplain mounds of coarse material, built from out-of-bank disposal constitute >800,000 m^3 in the study area. Approximately 7.7×10^6 m^3 of sediment was dredged within the study reach, roughly 11% of the volume dredged remains on the floodplain. Sand bars were disposal sites thus their increased area of 263% is partly tied to this practice. Thus, the legacy of dredging affects the modern sedimentology and morphology of the floodplain and channel. Findings show that a failed navigation project could have been pre-empted with better geomorphic, geologic and hydrologic study and suggest that vegetative restoration of point bars would help in narrowing and stabilizing this dynamic system.

1. Introduction

Sediments displaced by anthropogenic activities can affect channel form, both locally, and over larger spatial scales by altering sediment budgets and channel processes (Gilbert, 1917). By excavating sediments from the channel bed and disposing of them at a different location, dredging alters river channels (cross section and long profile), and in many cases, floodplains. Rivers and floodplains most prone to dredging and thus most vulnerable to dredging impacts include large rivers deemed navigable, those with floodplains protected by artificial levees comprised partly of dredge material, or rivers channelized for flood control. Some examples of such impacts include the channelization of the naturally meandering Lower Kissimmee River, Florida, into the straight C-38 channel during the 1960s (Toth, 1995; Mossa, 2015), and dredging of the lower Mekong River in Vietnam in the 1990s to reclaim wetlands, build berms on channel banks, and to provide construction aggregate (Bravard et al., 2013). The lower Mississippi in Louisiana is dredged for navigation, and that material is then used to build artificial levees (Yuill et al., 2016), but it is a perpetual process. Dredging along the Nile is considered a mixed prospect that requires careful study and has locally resulted in lower water levels (Ismail and Samuel, 2011) with some sediment being used to increase the area of mid-channel islands (Sadek, 2013). Bed levels along the lower Rhine River in Germany are maintained by a combination of sediment additions in reaches with sediment deficits and dredging in reaches undergoing shoaling (Frings et al., 2014), an intensity of management feasible only in rivers that serve an important economic function. Dredging alters many rivers and floodplains, but comprehensive geomorphic and sedimentologic studies of these impacts are lacking.

Very few studies have examined spatial and temporal variations of dredging and spoil deposits along rivers in the context of long-term alterations. This study investigates the anthropogenic landforms and sediments associated with a failed navigation project on the Apalachicola River in northwest Florida, southeastern USA. The focus is on the middle portion of the river between river miles (RM) 40 and 65, a zone in which

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disposal of dredged material in the floodplain and river corridor produced morphological and sedimentological changes in the channel and floodplain. Associated concerns include direct and indirect losses of riverine habitat affecting listed freshwater mussels and important swamp tree species. This analysis synthesizes archived USACE (U.S. Army Corps of Engineers) reports, historical maps and imagery, Light Detection and Ranging (LiDAR) data with primary bathymetric and sedimentological data to interpret floodplain deposits, channel changes, and the role of human activities in the study area.

2. Regional setting

2.1. Physical conditions

Draining approximately 50,945 km^2 (19,400 mi^2), the Apalachicola River begins at the confluence of the Chattahoochee and Flint rivers at the state boundary between Georgia and Florida (the confluence is now under the waters behind Jim Woodruff Dam), and then flows 170 km through Florida to the town of Apalachicola on Apalachicola Bay (Fig. 1). Commonly known as the ACF basin, most of the river's drainage area, approximately 44,550 km^2 (17,200 mi^2), lies in Georgia and Alabama.

The main channel of the Apalachicola River has a dominantly meandering form at low flow. Many secondary channels become active at various flow levels. More than 300 sloughs connect to the main-stem river, with over 370 km (230 mi) of length (Light et al., 1998). The largest tributary to the Apalachicola itself (i.e., below the confluence of the Chattahoochee and Flint rivers) is the Chipola River, which drains a catchment of 3290 km^2 (1270 mi^2) in Florida (mostly) and Alabama, and connects with the main-stem Apalachicola about 67 and 45 km (41.5 and 28 RM) upstream of Apalachicola Bay. Flow in the lower Chipola River is augmented by flow diverted from the main-stem Apalachicola River through the Chipola Cutoff, about 66 km upstream of Apalachicola Bay. Streamflow from the Chattahoochee and Flint river basins comprises most of the Apalachicola's discharge, with local precipitation, groundwater discharge, and other inputs contributing

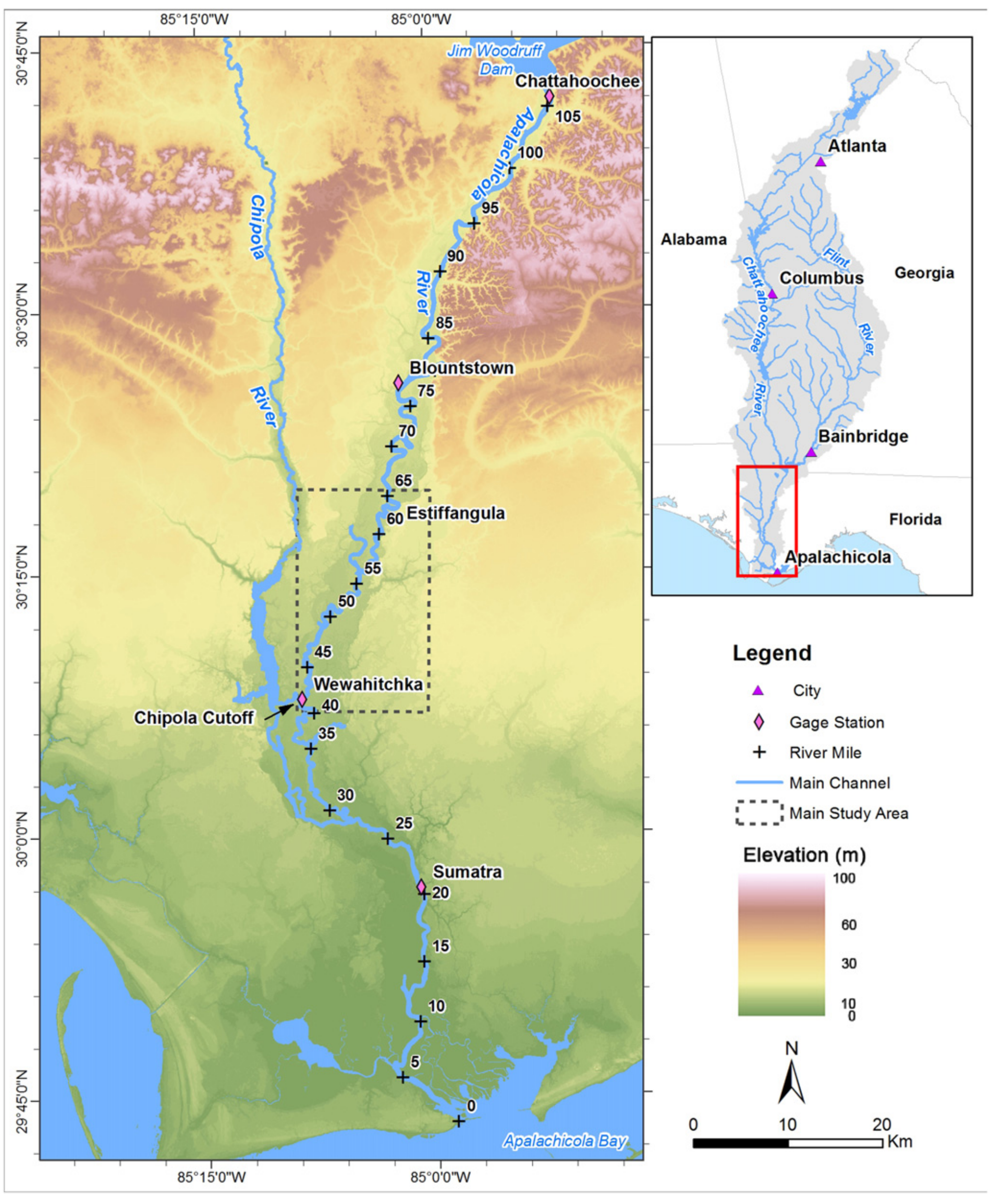

Fig. 1. The Apalachicola River and its drainage. The Chattahoochee and Flint rivers are shown in the inset. The Apalachicola River originates at the confluence near the Florida boundary, held back in part by the Jim Woodruff Dam. A large tributary, the Chipola River, joins farther south.