Anthropocene 11 (2015) 35–47

Contents lists available at ScienceDirect

Anthropocene

journal homepage: www.elsevier.com/locate/ancene

Anthropic signatures in alluvium of the Upper Little Tennessee River valley, Southern Blue Ridge Mountains, USA

Lixin Wang*, David S. Leigh

Department of Geography, University of Georgia 210 field Street, Athens, GA 30602-2502, USA

ARTICLE INFO

Article history:
Received 22 September 2015
Received in revised form 28 November 2015
Accepted 28 November 2015
Available online 2 December 2015

Keywords:
Stratigraphy
Sedimentology
Sedimentation
Soil chemistry
Geochemistry

ABSTRACT

Human activities have become important influences on the fluvial systems of eastern North America since post-colonial settlement. This research identifies post-settlement anthropic signatures in alluvial sediments in the Upper Little Tennessee River, USA. Agricultural and mining activities were scattered and discontinuous in this relatively remote region of the Southern Blue Ridge Mountains. We compared physical and chemical characteristics of sediments in post-settlement and pre-settlement stratigraphic units at three separate sites. Chronologies were calculated using non-linear power functions based on radiocarbon and optically stimulated luminescence ages, as well as dates from ^{137}Cs and historical records. These chronologies suggest that sedimentation rates increased with time during the post-settlement period but decreased with time during the pre-settlement period. In addition, long-term average sedimentation rates are one order-of-magnitude higher in the post-settlement time than in the pre-settlement time. Sediment becomes finer upward through the pre-settlement unit but coarsens-upward in the post-settlement unit. Statistical analyses on adsorbed elemental concentrations suggest that three elements (Ca, Hg, Pb) clearly differentiate sediments between pre-settlement and post-settlement periods. The identified anthropic signatures thus include higher sedimentation rates, coarser sediment texture, and higher concentrations of the three elements in the post-settlement units. These characteristics likely reflect human activities such as commercial timber harvest and scattered gold mining in the late 19th and early 20th century, modern agricultural practices, and urbanization since the 1970s. Findings of this study demonstrate significant impact on fluvial systems in regions with very limited history of intense human activities. This history stands in stark contrast to other parts of the world, like Europe and Asia, that record thousands of years of anthropic impact.

1. Introduction

Climate change and human activities are the primary drivers of floodplain sedimentation in the late Holocene (Knighton, 1998; Charlton, 2008). Stratigraphic records of floodplain sedimentation provide important information about variations in climate and human impact on the landscape, and geomorphic processes (Gregory et al., 1995; Knighton, 1998; Knox, 1987, 2001, 2006; Macklin and Lewin, 2003; Lewin and Macklin, 2005). In many parts of the world such as Europe, Asia, and the Middle East, human activities have a long and continuous history so that anthropic signals appear early within the Holocene (Kalis et al., 2003; Xu, 2003; Jones et al., 2013; Leigh et al., 2015). In contrast, in North America, it is generally regarded that the most pronounced and significant human impacts on the fluvial system did not begin until after settlement by non-indigenous people (Trimble, 1974; Jacobson and Coleman, 1986; Knox, 1987; Ambers et al., 2006; James, 2011). We refer this time period as the post-settlement period. Although some have argued that Native Americans accelerated erosion and sedimentation in eastern North America from agricultural activities during the last 1000 years including the Mississippian and Cherokee cultural periods (Stinchcomb et al., 2011; Dotterweich et al., 2015), such effects may be spatially isolated and not necessarily transmitted to river floodplains. In fact, it has been demonstrated that such pre-settlement impacts are not apparent in the alluvium in the Upper Little Tennessee basin (Leigh, 2016).

It can be difficult to distinguish the anthropic signals in fluvial sediments from climate signals in regions where significant human activities started thousands of years earlier (Wolf et al., 2014), but in many places in North America, there are clear distinctions between floodplain sediments of the pre-settlement and post-

* Corresponding author. Fax: +1 706 542 2388.
E-mail address: lixin0@uga.edu (L. Wang).

http://dx.doi.org/10.1016/j.ancene.2015.11.005
2213-3054/

settlement periods that signal human activity. Many studies have found significant differences of overbank sediments between the two periods in terms of sediment textures, sedimentology and sedimentation rates (Lecce, 1997; Knox, 2001, 2006; Benedetti, 2003; Leigh, 2016). Accelerated upland erosion and surface runoff, resulting from intensive human activities such as row-crop agriculture, timber harvest, and land clearing for construction during the post-settlement period (Glenn, 1911; Happ, 1945; Trimble, 1974; Leigh, 2007), has caused coarser sediments and greater sedimentation rates than those of pre-settlement time (Miller et al., 1993; Knox, 2001, 2006; Benedetti, 2003; Leigh, 2016). In addition to the physical characteristics, chemical characteristics vary significantly as well. For example, the lead and zinc content in overbank sediments increased greatly in the upper Mississippi valley during the 19th century due to mining activities (Knox, 1987, 2006). Mercury (Hg) and gold (Au) concentrations were distinctively higher in post-settlement sediments of Georgia and North Carolina because of past gold mining (Leigh, 1994, 1997; Lecce et al., 2008, 2011; Pavlowsky et al., 2010).

The signs of increased human activity in fluvial sediments are most apparent in regions where post-settlement agricultural and mining activities were long-lasting and pronounced. However, less study has been done in the more remote highlands of the Southern Blue Ridge Mountains, where historic subsistence agriculture was discontinuous and mining activities were low-intensity and scattered. Our research studies sedimentological and geochemical characteristics of overbank sediments in the Upper Little Tennessee River valley, a small catchment in these relatively remote highlands. Here we examine the differences between anthropic post-settlement and background pre-settlement periods and identify clear indicators of human impacts on fluvial sediments.

2. Study area

The Upper Little Tennessee River drains a 363 km^2 catchment above the United States Geological Survey (USGS) gaging station near Prentiss (USGS gage 03500000), with elevations ranging from 510 to 1600 m above sea level in northeast Georgia and western North Carolina (Fig. 1). The representative bedrock of the region is quartz dioritic gneiss and biotitic gneiss (Hatcher, 1988; Daniel and Payne, 1990; Robinson, 1992), which has been weathered to form a 1–30 m thick mantle of saprolite. The texture of saprolite ranges from sand to clay loam, providing abundant fine sediments to the drainage network (Price and Leigh, 2006; Leigh, 2010). Entisols and inceptisols are common soil orders on floodplains and the first terraces, which are derived from reworked saprolite, alluvium or colluvial deposits (Leigh, 2010). The Upper Little Tennessee River flows north and is fed predominantly by east- and west-flowing tributaries (Fig. 1). The morphology of the channel is characterized by meandering riffles and pools with coarse bed sediments of cobbles to coarse sand, and with finer overbank sediments of fine sand, silt and clay (Price and Leigh, 2006). The region lies in a humid temperate climate zone, with 30-year (1981–2010) average annual precipitation of 1752 mm and average annual temperature of 13 °C, as recorded at the low elevation climate station of the Coweeta hydrological laboratory.

Humans have been present in the region since the terminal Pleistocene but hunters and gathers of the early and middle Holocene were scattered in low density groups around the southeastern U.S. Permanent Native American settlements relying on maize and bean agriculture blossomed around 1000 years ago during the Mississippian cultural period (Delcourt et al., 1986). They were settled mainly on the floodplains with easy access to water and rich alluvial soils for agriculture practice (Swanton, 1946; Gragson and Bolstad, 2007). The indigenous

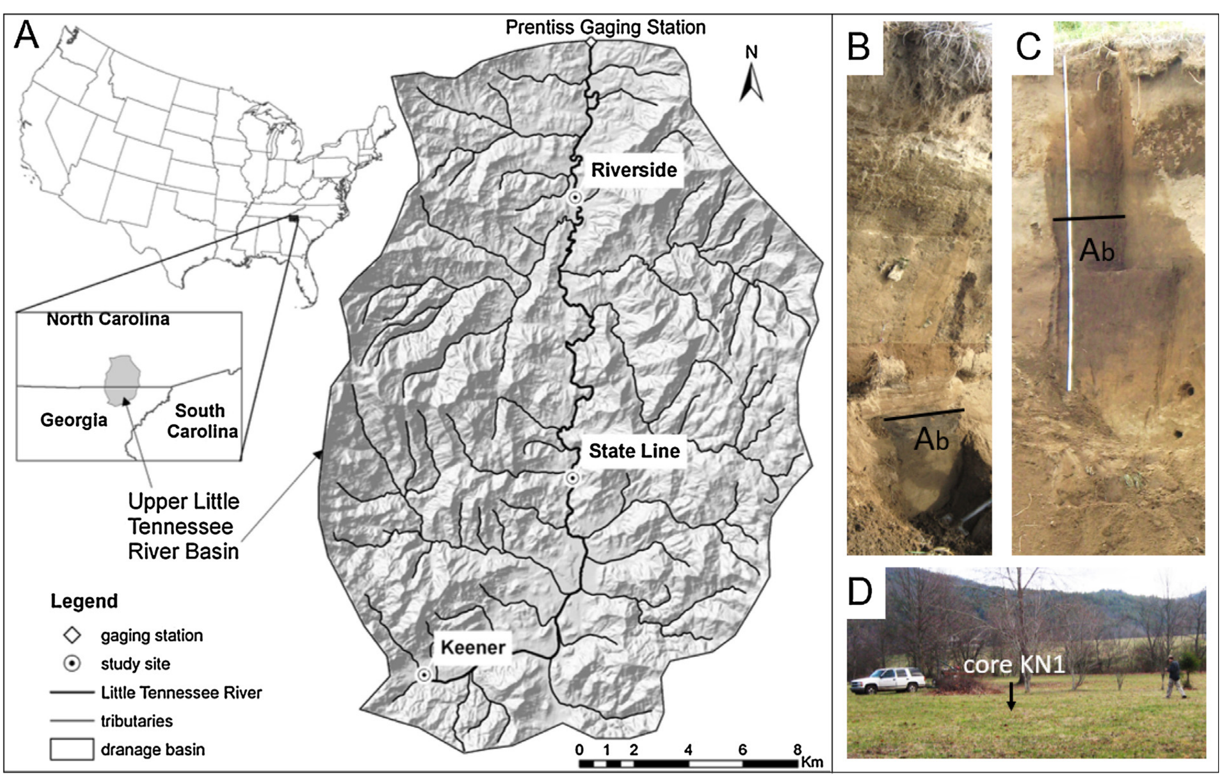

Fig. 1. A. Location of the Upper Little Tennessee River Valley and the three sites in this study (Wang and Leigh, 2012). B. Vertical profile of the State Line site; C. Vertical profile of the Riverside site; D. Landscape of the Keener site and the location of core KN1.