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# A Review of Holocene Avulsions of the Tigris and Euphrates Rivers and Possible Effects on the Evolution of Civilizations in Lower Mesopotamia

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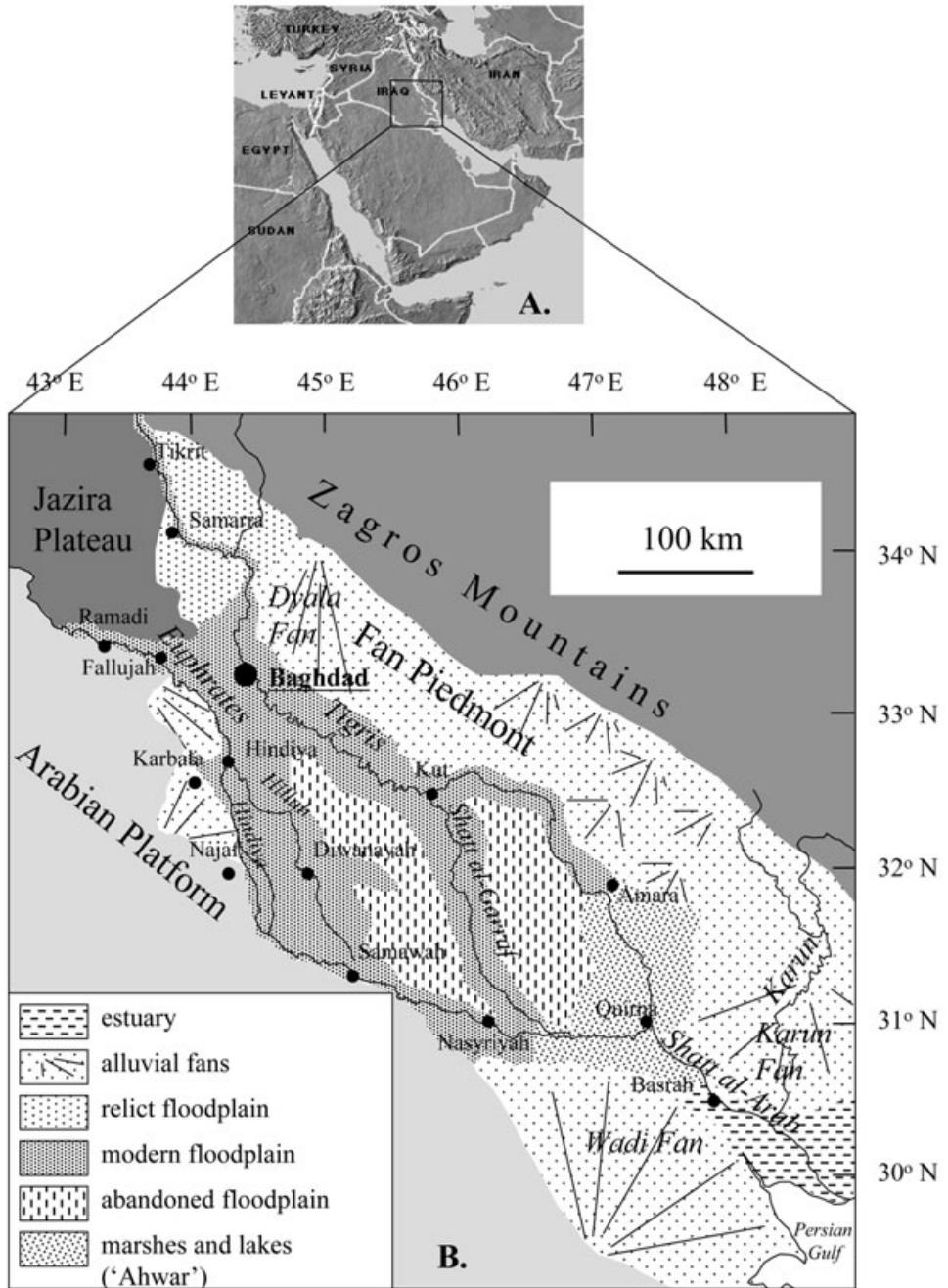
The role of avulsion in the evolution of civilization in lower Mesopotamia is widely recognized. Ancient settlements are closely associated with abandoned courses of the Euphrates and Tigris Rivers. This paper discusses avulsion history, controls of avulsions, their effects on civilization evolution from 7000 to 1000 yr B.P., and interactions between human activity and channel-network evolution based on previous archaeological and geomorphological surveys, analysis of cuneiform texts, maps, satellite photos, and limited geological data. Settlement distribution in ancient Mesopotamia is modeled in relation to avulsion styles, as well as channel and sedimentation patterns. Avulsion belts are suggested as places where urban settlements emerged and were sustained. Multiple channel networks and avulsion belts created large, naturally irrigated areas, fostering the efficient agriculture needed to sustain dense rural and urban settlements. After channel networks were abandoned during delta evolution, large-scale canal construction was required to sustain settlements but still could not prevent their decline. © 2005 Wiley Periodicals, Inc.

## INTRODUCTION

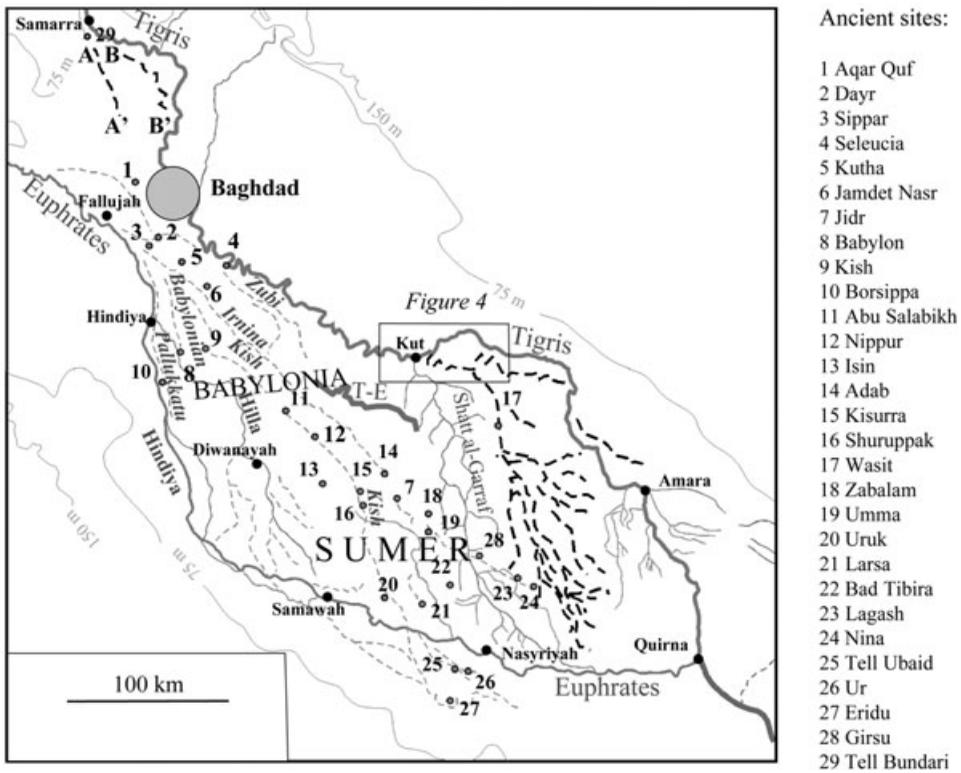
Ancient Greeks called the area of the world's first civilization, lying between the Euphrates and Tigris in present-day Iraq, "Mesopotamia" or "the land between two rivers" (Figure 1). Today, the landscape of southern Mesopotamia is a mosaic of desert and irrigated fields. The desert consists of extensive tracts of mobile barchanoid sand dunes, scattered low archaeological mounds, and broad saline flats. Modern fields irrigated with Tigris and Euphrates waters now cover large areas that are gradually encroaching upon the desert. The isolated archaeological mounds that rise above this bleak and monotonous plain are the remains of ancient villages and cities (Figure 2) that, at their maximum sizes during the 3rd millennium B.C., extended over as much as 400 ha and contained as many as 80,000 people. This early literate civilization largely depended upon the flow of the Tigris and Euphrates Rivers for its survival (Mackay, 1945; Schumm, 1977; Oates, 1979; Adams, 1981; Curtis, 1982; Mirsky, 1982; Saggs, 1988; Diakonoff, 1991; Cole and Gasche, 1998).

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**Figure 1.** (A) Map of the Middle East (courtesy of Oriental Institute, University of Chicago). (B) Major physiographic units of lower Mesopotamia (Sanlaville, 1989; Verhoeven, 1998; Uchupi et al., 1999).



**Figure 2.** Ancient courses of the Tigris and Euphrates in lower Mesopotamia (Gibson, 1972; Oates, 1979; Adams, 1981; Saggs, 1988; Northedge et al., 1990; Cole and Gasche, 1998). Active channels are shown by solid gray lines. Solid black line labeled T-E indicates abandoned channel of the joint Tigris–Euphrates. Dashed gray lines and names in italic indicate abandoned courses of the Euphrates. Dashed black lines show abandoned courses of the Tigris. AA' and BB' indicate abandoned channels downstream from Samarra. Elevations above sea level are shown by two contour lines, 75 m and 150 m.

The Tigris–Euphrates delta was populated by farming communities probably since early in the Holocene. Mesopotamian history is conventionally divided into several periods (Table I). The world's first Sumer civilization, centered in the southern part of lower Mesopotamia, existed during the Sumerian period from about 3500 to 1600 B.C. Later, the centers of power shifted to the more northern parts of lower Mesopotamia, known as Akkad or Babylonia (Figure 2). Among the achievements of this early civilization are irrigation agriculture, flood-control systems, the world's first cities, codes of law, and cuneiform, the first writing system. Civilization suffered a general decline during the middle Islamic period around 1000 A.D.

Lower Mesopotamia had several material advantages over neighboring regions. The irrigated areas had higher and more reliable agricultural yields, and goods were

**Table I.** Chronology of Mesopotamian archaeology (Adams, 1981; Wilkinson, 2000).

Period		Date
Ottoman		1500–1918 A.D.
Islamic		637–1500 A.D.
Sasanian		226–637 A.D.
Parthian		125 B.C.–226 A.D.
Seleucid		331–125 B.C.
Achaemenid		539–331 B.C.
Neo-Babylonian		625–539 B.C.
Early Neo-Babylonian		1000–625 B.C.
Post-Cassite		1150–1000 B.C.
Cassite		1600–1150 B.C.
Old Babylonian	S	1800–1600 B.C.
Isin-Larsa	U	2000–1800 B.C.
UR III		2100–2000 B.C.
Akkadian	M	2350–2100 B.C.
Early Dynastic I–III	E	2900–2350 B.C.
Jemdet Nasr	R	3100–2900 B.C.
Uruk		3500–3100 B.C.
Ubaid		Prior to 3500 B.C.

redistributed much more efficiently along a network of waterways (Algaze, 2001). Rivers were important transport and trade routes with the mountainous regions to the north. In exchange for agricultural products, such as barley, wheat, cereals, and wool, lower Mesopotamia received metals, building and semiprecious stones, gold, and timber (Mirsky, 1982). Rivers were especially valuable for the transport of high-bulk cereals from city to city. Bifurcations in the channel network provided ideal opportunities for early rulers of the region to exert control over downstream polities. All of these factors either directly or indirectly stemmed from the fluvial geomorphology of the Mesopotamian plains (Wilkinson, 2003).

Despite the observation by historian Will Durant (as cited by R. Byrne, 1988, p. 396) that “civilization exists by geological consent, subject to change without notice,” historians too often underestimate the influence of geological factors on human history (Mirsky, 1982). Some studies (e.g., Lambrick, 1967; Schumm, 1977; Woodward et al., 2001) suggest that the character of early civilizations may be greatly affected by rivers. The close association between ancient cities of lower Mesopotamia and abandoned watercourses of the Euphrates and Tigris has been widely recognized (Figure 2). In this paper, I address the possible roles that avulsion has played in the evolution of channel systems in lower Mesopotamia, and, therefore, by inference, in the regional development of early complex societies. Geological data from the Tigris–Euphrates delta are extremely scarce. I present existing evidence for avulsions of the Tigris and Euphrates, analyze their possible geological controls, and augment existing physical data with evidence from cuneiform texts that describe some of the practices of channel management. I further discuss how avulsion styles, as well as channel and sedi-