Marshland of Cities: Deltaic Landscapes and the Evolution of Early Mesopotamian Civilization

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Marshland of Cities:

Deltaic Landscapes and the Evolution of Early Mesopotamian Civilization

A dissertation submitted in partial satisfaction of the

requirements for the degree Doctor of Philosophy

in

Anthropology

by

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2003

The dissertation of Jennifer R. Pournelle is approved, and it is acceptable in quality and form for publication on microfilm:

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2003

DEDICATION

To Yvonne

They which collect truth out of fables, say, that Hercules…restrained the exorbitant overflowings of this river, with banks and trenches; and drained a great part of the adjacent country; and that this was the Cornucopia, which the poets made to be the emblem of plenty.

———Sir William Dugdale. *The History of Imbanking and Draining of Divers Fens and Marshes, Both in Foreign Parts and in this Kingdom, and of the Improvements Thereby*. London, 1772.

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PREFACE

Surrounded by artistically anthropomorphized salmon and waterfowl, I was born with an ocean view in the Pacific Northwest. Among my earliest memories are pausing (from gleaning a dinner's worth of mussels from spray-splashed rocks) to make ephemeral mosaics of pastel-hued butterfly clamshells along Puget Sound's chilly strand. My lungs fought unsuccessfully with the damp and mildew of Seattle's cold salt air, and so at six years of age we relocated to a warmer, drier clime. Hemet, California was then a sleepy agricultural community on the steppic fringes of the Mojave Desert, where my grandmother taught primary school. Her students, and my classmates, were a mixed lot. Half (like myself) were offspring of transplanted Midwesterners, lured by service jobs catering to the Sun Belt retirement industry. The rest were second-generation children of Mexican and Oklahoman farm workers, cast ashore from the Imperial–San Joaquin valley migrant labor corps.

Hemet lay just off the Colorado River aqueduct, which diverts half that river's flow nearly 400 kilometers across rocky cactus scrub to transform the Los Angeles basin into palm-bedecked garden lands. Along the way, where the aqueduct intersects the coastal piedmont, irrigation supplements the less generous supply from intermittent streams, and waters almonds and pistachios; apricots and pomegranates; dates and figs. To the southeast, another third or so of the Colorado's outflow makes a garden of a pocket carved into the Sonoran desert. Water diverted through the Great American Canal carpets the Imperial Valley with starkly green hay fields for Southwestern livestock, and table vegetables for America's kitchens.

Still not exhausted, the mighty Colorado, carver of the Grand Canyon, power source for Las Vegas, Nevada's desert-locked Sin City, staff of life for southern California, has more work to do before sinking into the sands at the head of the Sea of Cortez. To the south and east of El Centro and Mexicali, diverted and spread through a grid work of reed-lined irrigation canals, it carpets its own alluvium with another checkerboard of market-garden crops destined for Mexico's tables. Beyond these fields, under a pall of hanging dust, is a seemingly featureless landscape of grey powder and white salt pans—relics of what were, until even a few decades ago, vast wetlands covered with reed brakes and teeming with waterfowl.

Sucked dry by the 24 million inhabitants of Old California, this remote land along the thirty-second parallel is now so bleak that it served as the backdrop for a film set in an equally arid place: the southern Iraq–Kuwait border. Following the first (1991) Gulf War, the 1999 George Clooney vehicle "Three Kings" needed a landmine-free location to shoot a story set in the dusty, dried marsh fringes between Nasiriya and Basrah. So indistinguishable is the desiccated lower Colorado basin from the summer dustbowl westward of the Shatt al-Arab, that few viewers—and especially not those pre-conditioned by CNN's wartime video feed—realized that the film was not shot on location.

I have never visited Iraq. To do so has been impossible during the course of this writing. On the fringes of greater Mesopotamia, I *have* visited the Upper Euphrates in southeastern Turkey, where that river's waters, from behind the Ataturk dam, now rush out to irrigate the dusty barley stubble of the Harran plain, driving an economic boom lead by King Cotton, sugar processing plants, and cheap electricity. Further northwards, on the same longitude as the Shatt al-Arab's outflow to the Gulf, I have trudged across the scrubby salt wastes and relict shell beaches of the Kura-Araxes delta in Azerbaijan, where alluvial silt is, at alarming rates and with alarming frequency, alternately revealed and drowned by the landlocked Caspian Sea.

Closer to home, over the past five years I have visited (and re-visited with adult eyes) other proxies for the landscapes I herein pretend to describe, but in reality can only envision. The best-comparable, and to San Diego most easily accessible of these, was and is the Colorado delta, with its reed-lined Great American Canal, mollusk-laced spoil banks, Mexican wetlands now converted to agriculture, and desiccated outlets to the sea. To better imagine the outer delta south of Basrah, I also visited sloughs and estuaries of the admittedly much-smaller watersheds in southern California: the salt marshes and lagoons of the San Elijo, Rancho Peñasquitos, Sweetwater, and especially Tijuana Rivers. Upstream, I hacked and rode my way through their tangled riparians. Dense brakes and thickets of thorn- and razor-palm, giant reed, wild onion, garlic, mustard, and aromatic fennel—all invasive exotics, tracing their ancestry ultimately to the Tigris-Euphrates—closed in overhead, taller than horse and rider. Further inland, while at the height of summer the desert shimmered with 120-degree heat, I stood in the cooling shade of majestic medjool date palms—originally imported from Basra—that march in irrigated ranks through the Imperial Valley.

I can, from personal experience, only partly envision the freshwater marshes of southern Iraq so exquisitely documented by Wilfred Thesiger, Gavin Maxwell, Nik Wheeler, and several National Geographic teams. The great bayous of the lower Mississippi, where I tramped and fished during my early teen years, are wooded wetlands, ruled by great, dripping cypress trees. Similarly, the pocosins and riparian bottomlands of the Great Dismal Swamp, near my current residence, are swathed in stately water-loving evergreens. The cold lake shores of Upper Michigan, where I stole time away from undergraduate study, in summer ripple with sedges and cattail shimmering under clouds of biting midges and black flies, but I was never there at the appropriate season to see the great rafts of migrating waterfowl. My memories of them are in any case dominated by winter ice, not summer dust. I have had only brief exposure to the, in terms of latitude and ecology, best American proxy—that great southern Florida river of grass known as the Everglades.

Thus, like most Americans, and like most archaeologists, I peer at Iraq through several unavoidable screens. I can, through direct experience, more easily envision the lower Tigris and Euphrates as they are today—largely barren dustbowls, pocked by salt pans, thorny scrub, desiccated weeds, hungry donkeys, and the occasional green slash of a reed-lined canal—than I can as they were even two decades ago. I am fortunate to have at my disposal tools and evidence, built and gathered by others, to expand upon that experience—but they constitute a screen of their own. I have attempted to engage the available material with a kind of intellectual and (where I can) empirical honesty, but I must register many caveats.

First, I must be clear that I am not (or at least do not consider myself to be) a

Middle East or Iraq area studies specialist. I do not speak, read, or write any language that I would hold to be a minimum qualification for such a title. Neither am I an Arabist, Sumerologist, or Assyriologist—and, flattered though I would be were they to find it useful, I do not envision those who are as being a primary audience for this work. They have a command of the breadth and depth of cuneiform sources that I lack, even in translation. And I am not herein investigating questions regarding the "earliest occupation" of the Tigris-Euphrates delta, nor of the "origins of the Sumerians." At the time with which this investigation is primarily concerned, millennia of endogenous cultural development have quite clearly already taken place.

Second, while I do have some technical qualifications regarding the interpretation of surface topology in aerial or satellite photographs and imagery, that is not the same as formal training in geology or geomorphology. I am dependant upon professionals for explanations of the physical processes underlying the surface remains identifiable on imagery. No doubt there remains much regarding the earth sciences that I have not fully understood. However, I have expended some effort attempting to understand what, from the archaeological standpoint, "good" questions of these sciences might be. I must explicitly emphasize that the imagery investigation of Chapter Three is not intended to locate the "Gulf Head" in the sense of a line on the ground demarcating a particular shoreline at a particular date. Clearly, there has always been an inner and outer Tigris-Euphrates delta, subject to great local variability, and failure to understand this lies at the root of a failure to fully visualize the landscape of southern Iraq—both that of the very recent past and that of remotest antiquity.

Finally, there is a war on in Iraq even as I write. Oh, the shooting has stopped—at least, the organized shooting that accompanies tanks rolling across the desert has stopped—but the war of wills, contestations, counter-confrontations, and ideologies is far from over, and it will be some time before I or my successors can test on the ground any hypotheses presented herein. Where I do not have and cannot obtain archaeological evidence, I have perforce filled in with anachronistic ethnographies, geographies, travelogues, and histories (each subject of course to its own prejudices and biases). Where those have been unavailable, I have substituted proxy data from arguably comparable contexts. Of course, fundamental to this thesis is the indirect evidence coaxable from imagery. But I must note that the great photographic archives (ground and air) that I have consulted in my project to envision and re-envision both recent and distant pasts at the confluence of the Tigris and Euphrates are themselves products of grand political projects to physically control, assess, and restructure the very landscape that I attempt to describe. Some were recorded under conditions that at least make possible an attempt to understand what sort of data they systematically included or excluded. Others were subject to both the whims of their photographers, and the vagaries of historical preservation.

While not pretending to be an intellectual history *per se*, this dissertation of needs reflects an underlying interest in the Western and the Modern engagements with the region described herein, and with how Western thought and practice has constructed and deconstructed it over time. Rather than rigidly separating a past

Mesopotamia from a present Iraq, I see a great continuity in the dependencies and ambitions of its cities—and all cities—through time. Fundamentally dependent upon the great wetland sponges that sequester their water supplies, cities re-envision their hinterlands and subjugate them to various needs, agricultural and political. As the scale of urbanity has grown, so has the scope—some might say the folly—and certainly the fragility of that endeavor. Conversion of wetland to farmland, in an aim to maximize and regularize urban supplies of food, fodder, and construction materials, is nowhere undertaken with malicious intent (or at least only rarely so). But Iraq, past and present, has much to teach us about the inherent sustainability, fragility, and advisability of such endeavors. Against current media trends, I have done what little I can to refrain from exoticizing the locale by grounding my work in my own specific, local, available, contemporary context. In so doing, I readily accept that I, equally prejudiced by the limits of experience and accessibility, will inevitably fall victim to the same present-minded essentializing and universalizing tendencies that I critique, without intending to criticize, in my predecessors.

Sandy Creek, Durham, North Carolina

October, 2003

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Prof. Guillermo Algaze championed my admission to the fledgling graduate program in archaeology at UCSD, and since that day has been my constant mentor, advisor, and colleague. Among my many intellectual debts to him was his introduction to Prof. Robert McCormick Adams, who granted me free access to source materials, notes and maps from his series of surveys of the Mesopotamian alluvium. Had Adams not urged declassification of CORONA imagery (resulting in its retention, and public dissemination in 1997), and then (at a point in his career long past any obligation to do so) taken me on as his student, this work would have been both inconceivable and impossible. Their joint support introduced me to fora, communities of scholarship, colleagues, and opportunities I could not otherwise have imagined.

A stimulating UCLA Dept. of Near Eastern Studies seminar on the plants and animals of ancient Mesopotamia was the genesis of this dissertation effort. Co-lead by Professors Elizabeth Carter and Robert Englund, it served well its intended aim of bringing together textually-focused Assyriologists and materially focused archaeologists in mutually beneficial discussion. They have my sincere appreciation for their ongoing encouragement and liberal access to the unique resources of UCLA's Gelb library. Prof. Henry Wright provided day books, field notes and air photo tracings for the Eridu depression along with thoughtful guidance. His attentiveness from half a continent away has been deeply appreciated.

A special acknowledgement is in order to Tony Wilkinson and Nicholas Kouchoukos for including me in a series of landscape archaeology workshops held at the University of Chicago's Oriental Institute and Department of Anthropology 1999–2003. Those opportunities for intellectual exchange and outright tutelage were invaluable, as is their continuing encouragement, critique, and advice. The graduate students at the Oriental Institute's Center for the Archaeology of Middle East Landscapes are the very embodiment of CAMEL founder Tony Wilkinson's vision of integrating remote sensing, geomorphology, and archaeology. Jason Ur shared his workable "Chicago Protocol," a method for CORONA registration and georeferencing—providing an interim solution to a problem that has stumped a number of commercial and imagery professionals. Carrie Hritz selflessly provided copies of her prepared figures along with ASTER and georeferenced CORONA imagery, sparing us duplicating her efforts. Jessie Casana provided helpful pointers regarding 3D visualization and manipulation using DTED.

The directors and administrators of the University of California Institute on Global Conflict and Cooperation provided flexible scheduling, tuition fellowships, administrative support, and liberal leave that enabled my early graduate work. Chief administrator Susan Greer was exceptionally supportive in this regard. For the years 2000–2003, I was privileged to have been awarded a National Science Foundation graduate research (pre-dissertation) fellowship. The Smithsonian Institution, the National Geographic Society, and the University of California, San Diego Department of Anthropology provided essential equipment, space and operational funding to the Mesopotamian Alluvium Project, which made possible the substantial purchases of imagery, software, and processing without which my own work would not have been possible. This support was enhanced by equipment and software donations from INTEL and Microsoft. ERDAS, manufacturers of Imagine™, and Research Systems International (RSI), manufacturers of ENVI™, provided steep educational discounts for their software. Mike Stark keeps the ENVI server humming. Special thanks go to J.E. Pournelle and Associates, in the persons of my father, Dr. Jerry E., and brother, Alex, for building me a RAM-heavy INTEL-based image processing workstation for use while away from San Diego.

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Room, speeded my search through photographic records of expeditions to Ur. Helen George and Barry Bloomfield, photographic curators of the Oriental and India Office collections of the British National Library at St. Pancras accommodated my many requests to see “just one more” photographic album from the Bailey, Balding, Cameron, Curzon, Hall, Lorimer, Ludlow, Parke, Ross, Stein, and Thomas collections. Their colleagues in the Humanities 1, Science 2 North, and Map Reading Rooms were equally diligent in tracking down obscure pressmarks and accommodating my frantic dashes among them. Staffs of the reading rooms and reproduction center at the Public Record Office, Kew in Surrey were frighteningly efficient, delivering a myriad of materials nearly faster than I requested them. The sheer quantity of resources there was truly astounding. Kate O’Brian and Julie Hipperson at the King’s College, London Liddell Hart Center for Military Archives were pictures of grace under fire, as with overworked good cheer they produced magic boxes of maps and air photos from the Dimoline, Slade, Ismay, and Hamilton collections. Outside London, Geoffrey Waller, archivist at the Cambridge University Library Department of Manuscripts, assisted my search for a presentation album of air photos of Mesopotamian cities presented to Sir Samuel Hoare by the RAF Air HQ Photographic Section, preserved in the Templewood collection. Timothy Rogers, Clare Brown, Colin Harris, and Oliver House of the New Bodleian Library, Department of Western Manuscripts, Modern Papers Reading Room, Oxford University introduced me to the remaining fragments of vertical and oblique cover flown by the RAF in Iraq included in the Sir Aurel Stein collection. While in Oxford, I also consulted RAF air photos at the Middle East

Center, St. Antony's College in the Smith and Perowne collections. Barbara Cross at Mott MacDonald, Devon House, Oxford arranged on her own time for me to peruse what soil surveys and imagery remain from the transfer of Hunting Surveys archival holdings to Mott MacDonald in the 1990s. I am especially indebted to soil scientist and geomorphologist R. Neil Munro of North Berwick, East Lothian, Scotland for providing the introduction, granting me access to his substantial private collection, and for his considerable assistance in locating geomorphologic materials. Also in the North, the helpful staff at the National Archives of Scotland, Edinburgh tracked down an annotated photo album and photographic negatives, including a few 1925–26 verticals by 6 Squadron RAF, in the Stewart Peter collection.

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unanticipated delights regarding the very foundations of photogrammetry and aerial photographic science and engineering. Kury Erdman and the staff proved efficiently accommodating of my rushed attempt to see it all before departing. Mr. Fritz Kuby, map archivist at the *Militärgeschichtliches Forschungsamt*, Potsdam, was a dedicated professional who took great pains to understand my research aims and provide me access to uncatalogued WWI-era materials that I could not have imagined existed. Further south, the excellent color copy facilities at the *Bayrische Staatsbibliothek*, Munich, should be *de rigueur* for any map library. On my return to England, Nikolaos Galiasatos and Graham Philip at the University of Durham organized a small seminar and provided tours of their enviable facilities. I am grateful for their warm hospitality, and for the interest in and support for this project shown by the participants and their students.

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ABSTRACT OF THE DISSERTATION

Marshland of Cities:

Deltaic Landscapes and the Evolution of Early Mesopotamian Civilization

by

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Doctor of Philosophy in Anthropology

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Professor Guillermo Algaze, Chair

Prevailing theories of the evolution of early complex societies in southern Mesopotamia presume a uniform, arid landscape transited by Tigris and Euphrates distributaries. These theories hold that it was the seventh millennium BCE introduction of irrigation technologies from the northern alluvium to the south that began the punctuated evolution of Mesopotamian irrigation schemes. In this view, irrigation-dependent agro-pastoral production was the primary stimulus to urbanization and, millennia later, the emergence of city-states.

In this dissertation, I cast serious doubt on the landscape characterization underlying this model. I argue that much of the archaic alluvial landscape of southern Iraq consisted in large part, not of desert or steppe, but of wetlands, and that this finding requires a comprehensive reassessment of southern Mesopotamian resource management strategies and their role in emergent complex polities. Chapter One examines a Western Enlightenment tradition hostile to uncultivated wetlands. In Chapter Two, I discuss the role of imagery in archaeological research design, distinguish physical *terrain* from ideological *landscape* as objects of investigation, and address tendencies to conflate *visibility* of archaeological data with *visualizations* of the past. In Chapter Three, using satellite imagery to integrate geomorphologic and paleoclimatic evidence, I examine the Tigris-Euphrates delta, identify courses of the Tigris and Euphrates rivers, locate the Persian Gulf head, and reconstruct terrain surfaces as they may have appeared five—six thousand years ago.

In Chapter Four, I review assumptions about Mesopotamian cultural ecology, present material indications for settlements, waterways and associated terrain features, and discuss archaeological and ethnographic evidence for interactions between human and natural processes. I argue that a significant component of the resource basis for precocious, large deltaic towns was probably that derived from surrounding marshland; and conclude that only following specialization and integration of, not two, but three, productive economies: agricultural, pastoral, and wetland, could and did Mesopotamian urban civilization flourish.

Finally, in Chapter Five I consider how the landscape vision at the dawn of the twentieth century blinkered the view of colonial administrators, in ways that had a lasting impact on reconstructions of life in the lower alluvium. I contrast this with ways that wetlands may have been seen by proto-urban elites five millennia earlier, as they undertook their urbanizing projects that eventually converted socially unranked, undifferentiated wetlands, into alienated, ranked, extra-urban hinterlands.

I. INTRODUCTION

> I loved better [than Bombay] Egypt…where the clear desert air breathes health, not septic soddenness…And to Mesopotamia I turned, as to another Egypt.
>
> ———H. R. Hall, 1930: 7

In a recent issue of the New York Times, a one-third page advertisement confronts the reader with a sinister montage. Eyes obscured by the glare on his goggles, a weathered, straw-hatted man clutches a pitchfork, its tines thrust upward outside the frame. His image is under- and over-laid with blurred fragments: a tractor with climate-controlled cab, dragging an unidentifiable implement; generically Asian ideograms with what appears to be a male Asian face in vaguely ethnic headdress; a chick with eggs; an unopened ear of feed corn surrounded by sprays of ripe wheat; the word "Yes"; scraps of maps so placed that the word "Ethiopia" scrawls up his forearm like a badly-faded tattoo. Superimposed upon this collage is a globe portraying the Americas, circled and pierced by four arrows. Across it, in type so comparatively fine that one must peer to make out the text, is set the chilling question: "What if we looked at the world as one giant farm field?"

No doubt, the advertiser did not intend and would not see this composite to be in the least sinister. But its net effect is to obliterate an undifferentiated, chaotic background (and the fragmentary Asian farmer contained therein) with a clear, aggressive stance: pitchfork to the fore, North American farmers united with heavy equipment, engineered seeds, and battery incubators stand out against disorder. One need not look far for confirmation of this reading: in twelve-point type below the picture, the advertiser declares: “In tomorrow’s global food economy, every crop will grow where it grows best. And ADM can link farmers to almost any market in the world. It’s a natural way to improve agricultural efficiency, make food more affordable, and feed a hungry world. Nature has answers. Is anyone listening? Yes. ADM. The Nature of What’s to Come™.”

The drive for farming efficiency expressed in ADM’s advertisement is hardly new. Nor is it merely a recent iteration of “Green Revolution” agricultural development schemes that introduced high-yield, pest-resistant crops to wide swaths of Asia in the 1960s–70s (although it is that, too). It reflects a much older classificatory sentiment, deeply rooted in Western thought, that distinguishes “wasteful” from “useful” land usage practices, and “wasteful” from “useful” land. Most particularly, without the transformative hand of human engineering, that classificatory dichotomy has historically placed wetlands in the former category[1]—a schema that has shaped profoundly the way that archaeologists have examined social complexity in the prehistoric Middle East.

The eye casts back to the spindled globe. Clear to see above and below the text are Canada, the United States, and Brazil—three nations where, over the past three centuries, public planners indeed did and do look at the better part of two continents “as one giant farm field.” In *Ecological Imperialism*: *The Biological Expansion of Europe, 900–1900* (1986), geographer and historian Alfred Crosby elegantly and

[1] Witness Dawson’s 1930 report on Iraqi land tenure (p. 7): “About four-fifths of the country consists of unproductive or slightly productive desert, steppe, *marsh*, and hill masses” (emphasis added).

originally described the march of European crops, livestock, diseases, and barnyard pests across the Americas, Australia, and New Zealand—accompanied by a concomitant obliteration of life ways, species, and ecosystems.[2] While most are aware that crop and grazing land was won at the expense of former forests, fewer are acquainted with the impact of this expansion in coastal and deltaic settings. Unlike their early seventeenth-century counterparts, who highly valued salt meadows for thatch, forage and (indirectly as it was cycled through ruminant digestive tracts), upland fertilizer, by the end of that century English colonists had already hacked and drained their way through several thousand hectares of North American marshes and mudflats. Around thriving towns like Boston and New York, they felled trees, diked estuaries, dammed coves, and shifted tons of gravel landfill to make way for wharves, warehouses, millponds, and larger harbors. "Because the marshes seemed inexhaustible, colonists took them for granted," until by the mid-eighteenth century, forced to import salt hay from distant sources, livestock keepers found themselves in dire straights. Nevertheless, landowners near cities banded together in drainage projects that converted remaining wetlands from hay meadows to higher-profit garden crops—while farmers away from cities resisted the practice (Vileisis 1997: 31–33).

The tension between the aims of emergent urban mercantile capitalists, and

[2] Physician Jared Diamond has received much attention–and a Pulitzer Prize—for *Guns Germs and Steel: The Fates of Human Societies* (1997). However, the central tenets, structure, and even illustrative figures in Diamond's treatment were laid out a full decade earlier in Crosby's authoritative, Ralph Waldo Emerson Prize-winning paperback—and in the subsequent collection of Crosby's public lectures, entitled: *Germs, Seeds, and Animals: Studies in Ecological History* (1994).

those who raised and managed the livestock on which they depended for farm traction, land transport, and well-dressed tables, were not unique to the American colonies. Indeed, some of the colonists themselves were as much economic as religious refugees, driven from the broad Lincolnshire fenlands surrounding the English Wash by massive land reclamation schemes begun in the sixteenth century, aimed at bringing flood meadows under tillage (Harvey 2002). Both John Smith's and Ann Hutchinson's colonial expeditions originated in the market town of Alford, where religious dissention went hand-in-hand with unsuccessful resistance to the progressive subjugation of the landscape by absentee aristocrats. In 1662, English antiquarian and early modern historian Sir William Dugdale felt it necessary to defend the legitimacy of the reclamation practices, in a *History of imbanking and draining of divers Fens and Marshes, both in foreign Parts and in this Kingdom, and of the Improvements thereby, extracted from Records, Manuscripts, and other authentic Testimonies.*[3] The work was revised and corrected a century later by Charles Nalson Cole, and a second edition published in 1772. In it, Dugdale/Cole explicitly appealed to a series of proofs that equated embanking and drainage with great rulership. They argued that all the great biblical civilizations—Egypt, Babylon, Greece, and Rome—owed their wealth and prosperity to drainage works, and that the great English families had emulated this good work in the riparians of Britain.

The Dugdale/Cole apology demarcates an Enlightenment turn that would

[3] For a discussion of Dugdale's role in defining English antiquarian practice, see Lancaster 1999.

dominate Western thinking regarding wetlands for the coming two centuries.[4] Wedding the concepts of Biblical morality, urban civilization, technological innovation, and landscape transformation to productive increase (as defined by the urban landholder) (Glacken 1967), coastal wetlands, perceived little more than a century earlier as a source of productive ease, became redefined as waste land awaiting the firm hand of good governance.

During the nineteenth century, this transformative vision extended inland along vast river basins with their brush-choked, wooded, swampy backwaters. In the United States, bottom lands became timber lands, then crop lands. Technological innovation in logging rigs, ceramic tile manufacture for underdrainage, and trenching machinery steadily accelerated the conversion of millions of hectares by the turn of the twentieth century (Vileisis 1997: 116–127). Contemporaneously, half way around the world, in the 1875 *Statistical Account of Bengal*, Indian Civil Servant Sir William Hunter

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[4] A full exploration of these attitudes would require several volumes. Glacken treats at length eighteenth century attitudes toward wetlands (Glacken 1967: 654–705). Buffon's early eighteenth century conviction that "thickets, dense forests, accumulated organic debris, [and] poisonous swamps…were inimical to nature and to civilization," and that the vast marshlands remaining in America were "proof of the newness of the country, of the small number of inhabitants, and still more, their lack of industry" underpinned budding scientific authority (Glacken 1967: 670, 680). That during the following century cultural bias against marshes, swamps, and lowlands still held wide currency is perhaps exemplified by the preoccupations of influential British art historian John Ruskin. In his review of Tim Hilton's *Ruskin: The Later Years*, Valentine Cunningham notes "Ruskin's unquenchable enthusiasm for irrigation and drainage systems" (2000: 8). In his now-classic exploration of early twentieth century German masculinist ideologies, Klaus Theweleit (1974) dedicates an entire chapter to German biases against swamps. That these had deep cultural roots is evident in the now seldom-read second volume of Goethe's *Faust*, in which the protagonist, having been unfulfilled by all other offerings on this mortal coil, finally finds surcease as he contemplates draining his land.

portrayed the Sundarbans, “densely forested wetlands that cover the sea-face delta of the rivers Ganges and Bramaputra as they empty into the Bay of Bengal,” (Greenough: 237) as a tiger-infested, sodden wasteland. He warned: “So great is the evil fertility of the soil, that reclaimed land neglected for a single year will present to next year’s cultivator a forest of reeds…The soil, too must be cultivated for ten or twelve years before it loses this tendency to at once cover itself with jungle weed” (Greenough 1998: 249). By 1890, once a vast commons, “most of the Sundarbans had been declared ‘reserved and protected’ under the supervision of a Deputy Conservator of Forests,” with authority to charge user fees, assess tolls, issue licenses, and grant leases (Greenough 1998: 261, 271 n. 83).

In the Middle East, by the later nineteenth century, British explorer-merchants in Egypt had slogged their way from Cairo upriver through the seasonally inundated Sudanese floodplains. In the same year that the Sundarban mangroves passed to the control of the Imperial Raj, convinced that the security of Britain in Egypt depended upon rejuvenating downstream triannual crop irrigation systems, Sir Colin Scott-Moncrieff recruited hydrologists and engineers from the Indian irrigation service. These included Sir William Garstin, who proposed, Sir William Willcocks, who designed, and Sir Murdoch MacDonald, who built the first Aswan Dam, completed in 1902 (Collins 1990: 107–108). Garstin was not enamored of the vast, wet heart of the Shilluk, Dinka, and Nuer cattle lands, although he and Willcocks both understood well their natural role as flow regulators (Collins 1990: 92, 99), “No-one who has not seen this country can have any real idea of its supreme dreariness and its utter desolation,” he wrote. "To my mind, the most barren desert I have ever crossed is a bright and cheerful locality compared with the White Nile marshland." (Garstin 1909, in Collins 1990: 66). The successive dams at Aswan have since come to symbolize modernist, technocratic schemes to fully control entire river basins, from their headwaters to the sea. No sooner was the first complete, than Garstin proposed that a new channel—the lineal ancestor of the Jonglei Canal—be cut to divert White Nile flow directly to Egypt, without "wastage" from evaporation in the swamps (Collins 1990: 101). Proponents would later argue that the bypassed regions would benefit from the water diversion, as they were "better suited" to rain-fed agriculture. The project—often fiercely resisted by upstream users dependent upon seasonal pasturage rejuvenated by wetlands ebb and flow—was finally abandoned in 1988.

Having established his hydrologic expertise in Egypt, at the invitation of the Ottoman government Willcocks carried his totalizing hydrologic ambitions to Mesopotamia—"the land between the rivers" that slices through present-day southeastern Turkey, Syria, and Iraq (see Figure 1, Figure 90)—where he envisioned a complete re-engineering of the Tigris–Euphrates delta. He designated vast reaches of the alluvial plain as amenable to early development, proposed a series of flow diversions, drainage trenches, regulators, and reservoirs, and built an ill-fated flood control barrier at Hindiyah. Drainage efforts were to be enhanced by cutting new channels to discharge outflows directly into the Persian Gulf. These engineering works would systematically empty marshes, lower the saline water table, rationalize irrigation systems, and thereby reclaim "waste" land for high-profit agricultural production (Willcocks 1917).[5]

Interrupted by wars, coups, revolutions, and remapped political boundaries, under a succession of governments in four nations (Turkey, Syria, Iran, and Iraq), the transformative vision of Willcocks and his successors has proceeded along the twin rivers for the past century. In a United Nations report, based on National Aeronautics

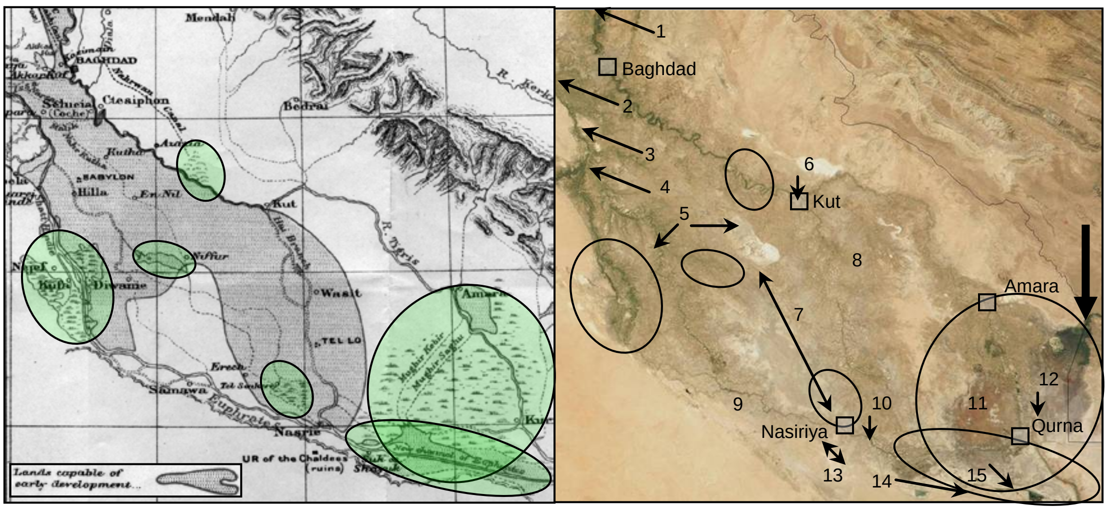

Figure 2: Marshes of the Mesopotamian alluvium (circles), 1908 (L) vs. 2000 (R). Willcocks's map shows approximately 20,000 km^2 of primary (year-round) and secondary (seasonal) wetlands. Flood control and drainage projects have reduced that area to less than 1000 km^2 of rapidly-diminishing marshlands (black, arrow) east of Amara. Most of that reduction has occurred since 1990. (1) Samarra–Tharthar Dam and canal, 1954. (2) Ramadi–Habbaniya dams and canals, 1956. (3) Felluja Dam, 1985. (4) Al Hindiyah Dam, al-Hilla Canal, 1918, 1989. (5) Greater Mussayib reclamation, 1956–99. (6) al-Kut dam, 1939; Dujailia reclamation, 1953–7. (7) Main Outfall Drain–Third River 1953; 1972; 1990–92. (8) East Gharraf reclamation 1952–68. (9) Al-Qadissiyah River, 1993. (10) Suq el-Shuyoukh regulators, 1956. (11) Polder dykes and canals, 1993–94. (12) Military causeway, 1980–88. East–West canal, 1992. Prosperity River, 1993. (13) Mother of Battles River, 1994. (14) Fidelity canal, 1997. (15) Shatt al-Basrah canal. Sources: Willcocks 1917, Iraq 1956, Partow 2001, NASA 2001a, Brasington 2003. Image: MODIS April 1999.

[5] Initially, the Hindiyah barrage diverted water to the Shatt al Daggarah, initiating a renaissance of settlement around Fara (Shurrupak), but it was overwhelmed by a great flood in 1918. See Adams and Nissen 1972.

and Space Administration (NASA) analyses of LANDSAT satellite images, Hassan Partow documents the outcome of the systematic flood control, damming, and drainage aimed at asserting centralized political authority and expanding agricultural export production: the demise of the vast marshlands of southeastern Iraq. (MacFayden 1938; Iraq 1956; Cotha Consulting Engineers 1959; Koucher 1999; Partow 2001; NASA 2000, 2001a, Brasington 2003). The LANDSAT multispectral system, released to public access in the early 1970s, was itself produced in response to demands for an accessible aid to landform analysis, to be used in part in service to regional development schemes. Within the public arena, LANDSAT launched hopes that satellite imagery would both expand coverage and lower costs over those of traditional aerial photography. But imagery of this kind was barely imaginable to archaeologists and public planners when, in the 1950s, the Iraqi government contracted for a series of engineering studies aimed at harnessing the water and power of the Tigris and Euphrates rivers. Among its aims, the Iraqi monarchy then reigning intended to implement the ambitious schemes first proposed by Willcocks a half-century earlier.

Thus, both the demise of the marshlands and their documentation are in a sense a terminal outcome of those nineteenth century beliefs that marshes are inherently diseased, sodden wastelands, and that the appropriate effort of good government was to transform them into cultivated agricultural land. For the purposes of this study, it is important to note that the Enlightenment, Victorian, and Modern emphases on transforming “waste” wetlands for “useful” agricultural endeavor were especially operative during the formative period of Mesopotamian archaeology and Assyriology. As is revealed in the epigraph that begins this chapter, engineers and archaeologists alike viewed marshes as worse than deserts—a notion confirmed to them by the desertic locale of long-abandoned Egyptian and Mesopotamian cities. A prime example of this linkage is Ragozin's *The Story of Chaldea. From the Earliest Times to the Rise of Assyria*, first published in 1886 as a volume in Hutchinson's school text *Story of the Nations*. Widely read for decades in multiple editions as a general introduction to the study of ancient history, Ragozin summarized for the young, educated reader exciting discoveries in biblical Shinar. Still in print,[6] her colorful illustration of pre-literate, pre-civilized Sumerians anchoring, behind reed-and-earth dams, baskets of muck dredged from a waste-deep mire remained imbedded in research paradigms through the mid-twentieth century that viewed the birth of Mesopotamian civilization as a process of "reclaiming" primordial lands for irrigated plow agriculture (e.g. Sousa 1983).

Thus, in examining the precursors of social complexity in the Middle East, consideration of riparian, lacustrine, estuarine, and marine littoral (referred to collectively hereinafter as "wetland") resource exploitation for the most part has been subordinated to close examination of agro-pastoral economic components characterized by grain cultivation and ungulate husbandry (Pollack 1992, Kouchoukos 1998, Zarins 1990). Naomi Miller has succinctly summarized this overarching view: "By about 6000 BCE, domesticated animals, notably sheep, goat, and cattle, had joined

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[6] Long Beach, CA: LAME Publishing.

the familiar crop complex of Near Eastern cereals and pulses, forming the economic basis of later Neolithic society and the first civilizations" (Miller 1991: 144–45). Underlying prevailing models of the Mesopotamian path to complexity (such as Jacobsen 1957: 97–98, Wittfogel 1955, Diakonoff 1974, Adams 1981, Charvát 2002: 59) is the primary assumption that extension of sedentary agriculture made possible the hydrologic engineering used to intensively exploit arid settings wherein, as compared to equal hectarage in rain-fed agro-pastoral economies, exponential agronomic return was possible per unit labor input. Following Frankfort (Frankfort 1932: 18) and Perkins (Perkins 1949: 73), despite hints offered by remains of burnt fish excavated at Eridu, Ur, Uruk, Tello, and Tell Asmar (van Buren 1948: 103–4; Potts 1997: 34), the southern Mesopotamian wetlands were tacitly viewed as an impediment to expanded irrigated grain production, and hence expanded urbanity, until the region became sufficiently "dry" during the late-fourth millennium BCE Uruk period (Nissen 1988). "The South," meaning either all of the alluvium below Baghdad, or only that most southerly portion encompassed by ancient Sumer, was recognized as a locus of presumptive colonization by irrigation technologies from "the North," meaning variously Syro-Anatolia, Assyria, the Zagros piedmont, or the northern margins of the alluvium (Samarra).

These views have proven remarkably persistent, despite the obvious wetland setting of many of the world's early complex societies in the Nile (Egyptian), Indus (Harappan), Yangtze and Huang (Yellow) (Shang), Tabascan (Olmec), and other deltas. Early on, New World archaeology should have posed serious challenges to the implicit drain-and-civilize model: raised field agriculture clearly depended upon *maintaining* highland wetlands in Mexico (Brumfiel 1976; Steponaitas 1981) and the Altiplano (Kolata 1993).

Evidence also mounted from around the Pacific Rim of mollusk and anadromous fish exploitation as a basis for early sedentism and territorial consolidation (Aikens 1981; Moseley 1975; Akazawa 1981; Pearson and Underhill 1987), and Murdock noted as early as 1969 the high correlation between specialized fishing economies and early sedentism in non-maritime contexts. Moseley's revolutionary work in South America specifically linked ENSO oscillations to marine bioproductivity and urban origins (Moseley 1975). [7]

That the role of wetland exploitation in early Near Eastern sedentism and social evolution has received insufficient attention is perhaps unsurprising on purely

[7] Relevant literature is becoming unwieldy, but with no good synthesis. Nicholas (1998) reviews hunter-gatherer studies in wetland settings. Hoffman (1969) documents the displacement of sizeable Native American mid-Atlantic coastal wetland settlements by early colonial encroachment. For other recent work in North America, see (Mississippi Valley): Bernick 1998 Part III and Saunders et al. 1997 on Poverty Point; Emerson and McElrath 1983 on Cahokia; Goldstein 1997 on Azatlan. See Marquardt 1988 and Walker and Marquardt 2001 on the south Florida Everglades Calusa; Rountree and Turner on the mid-Atlantic Powhatan. For Europe, see Bernick 1998 Part I; Baldia 1993–2001, Chapter 4.2; Wallace 2000; Whittle 2000; and Gheorghiu 2003. For south Asia, see Belcher 1998 on the Indus Valley. For China, see overviews at Pearson and Underhill 1987 and Song 1998. See Lin, Wright, and Miller-Rosen 2002; and Miller-Rosen 2002 on the Yi-Lao river valley in western Hunan. See Jing, Rapp, and Gao 1997 and Underhill, Feinman, Nicholas, Bennet, Cai, Yu, Luan, and Fang 1998 on the Huang (Yellow) river floodplains in southeastern Shandong. See Miyatsuka, Uno, and Sakamoto 2002 for visualizations on the Yangtze. For Southeast Asia, see Stargardt 1998 on South Thailand, and Stark 2002 on the Lower Mekong. For Australia, see Petersen 1973; Dortch 1997; and Builth 2002. Egypt is discussed below.

methodological grounds—most excavations in the region were conducted decades before the invention and introduction of systematic fine-mesh screening, floatation, and deflocculation for small and organic find recovery.[8] However, an antiquarian emphasis on hallmarks of "civilization" such as massive architecture and collectible *objets d'art* conspired with later searches for hallmarks of state governance, such as urban craft specialization and top-down irrigation schemes, to consign to the spoil heap or render invisible the ephemeral evidence of reliance on former wetlands even when it lay in plain sight.

Robert McC. Adams was among the first to seriously challenge this paradigm. In support of the Iraqi crown studies, KLM Dutch Airlines had been contracted to conduct systematic aerial photographic mapping of alluvial Iraq, and the Mesopotamian plain was rendered in a series of high-quality photographic mosaics intended to aid geomorphological studies. Adams, insisting that any characterization of Mesopotamian civil complexity must include due consideration of not just cities but their hinterlands, used these as an interpretive tool in contextualizing the results of decades of ground survey. He described a flexible social adaptation to an unpredictable and uncertain environment, comprising grain agriculture, livestock husbandry, and marshland exploitation. He examined not just the deep past, but its continuous transformation to the onset of modern age and its drainage efforts,

[8] Fish bones are in any event poorly preserved, but these methods result in an up to a hundred-fold increase in their recognition and, in the case of otoliths, MNI identification (Ross and Duffy 2000; Payne 1972). Microscopic analysis of recovered scales further allows identification of additional species present (Desse 1983).

beginning with construction of a massive flood-control barrage at al-Hindiyah in 1918 (Adams and Nissen 1972; Adams 1981).

But access to the KLM photos was never guaranteed, dependant as it was on the vicissitudes of geopolitics and the variable good will of Iraqi officials. And during the subsequent decades, it became apparent that LANDSAT could and would not reveal the fine detail of small site locations and associated ground features that had made possible his ambitious study. By the early 1990s, even as the final drainage installations were emptying Lake Hammar of water, understanding that a lasting impact of the first Gulf War would likely be to constrain further photographic access for decades, Adams and others successfully lobbied for declassification of, preservation of, and public access to a hoped-for replacement from the United States military sector: satellite photographs, code-named CORONA. In 1997, near-world-wide CORONA coverage was made publicly available at low cost through the United States Geological Survey's web-based order system. Over the next several years, the United States National Imagery Management Authority released to the public domain, at no cost in downloadable digital form, two more near-world-wide imagery datasets: SPOT, and imagery-derived digital terrain models (DTED). Complementing the monochrome SPOT, at higher resolution than the old LANDSAT workhorse, NASA also released ASTER. From an archaeological perspective, the timing of these releases could not have been better. They arrived on the heels of mounting evidence that a systematic examination of newer geomorphologic, archaeological, glyptic, and textual data from fifth–fourth millennium BCE Mesopotamia was overdue.

Collating available evidence requires a coherent methodology for addressing problems on a regional scale, using data collected under widely variant conditions and degrees of exactitude. In the next chapter, I propose a critical role for satellite imagery and, where available, ground and air photography in this process. In Chapter Three, results of recent geomorphological investigations that relate mid-Holocene Nile delta paleogeology to fifth millennium BCE site locations provide a point of departure for interpreting the recently-declassified CORONA photography and newer imagery of the southern Mesopotamian alluvium—a dataset especially useful in that the region so considered will remain closed to regional coring operations for the near future.[9]

In the Nile delta, Neolithic and early Chalcolithic sites, instead of being aligned along archaic watercourses discharging into the Mediterranean, followed chains of Pleistocene "turtlebacks" extending across the alluvium, suggesting wet-season boat traffic (Van den Brink 1993; Butzer 2001). [10] In the fourth chapter I argue

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[9] This is not meant in any way to diminish the findings of site-specific geomorphological investigations upon which this study depends for ground truth of photographic analyses. However, political and security restrictions limit the areal extent of present and planned landscape investigations, and for now preclude replicating the Nile delta research design in lower Mesopotamia. That such research is warranted in many deltas is shown by Stanley and Warne 1994, 1997.

[10] The term turtleback is often conflated with the Arabic *gezira*, broadly meaning sand island, which is misleading for two reasons. Firstly, *gezira* (with many transliteration variants) is used to designate any island, plateau, or upland, including vast tracts of upper Mesopotamia. Secondly, turtlebacks are not necessarily sand, nor are they necessarily islands. Turtlebacks, in the sense used herein, are formed during pluvial periods (such as the Pleistocene), when meandering rivers down-cut through (relatively) uniform alluvial surfaces, leaving former surfaces exposed above the newly formed floodplain. The channels between these exposures infill during subsequent conditions of alluvial aggradation, leaving weathered humps of the older

that, similarly, in alluvial Iraq roughly south of the thirty-second parallel archaeologically visible early villages were concentrated on high ground at locations bordering swamps and marshes during the ‘Ubaid 0–3 periods (6500–4900 BCE). Further, half of the sites extant in the Warka and Eridu survey areas dating to ‘Ubaid 4 (4900–4350 BCE) were newly founded during that time. Of these newly founded sites, as in the Nile delta, all but one were founded on exposed surfaces of turtlebacks that once overlooked anastomosing distributaries subject to seasonal flooding.

As in Egypt, between these turtlebacks the Mesopotamian plains are for the most part buried under meters of alluvial accumulation, and we cannot know what sites are buried with them. Nonetheless, larger sites situated on the once-elevated turtlebacks *are* visible, and to date have been accepted as archaeologically (proto-)typical. These ‘Ubaid-period towns presaged an explosion of new (or newly visible) sites founded during the Early Uruk period, when virtually all identifiable turtlebacks became inhabited.

It is probably true that during historical periods of four thousand years ago the climatic regime of the southern Mesopotamian alluvium had dried to something approximating its present state, with urban pearls strung along riparian filaments. It is therefore unsurprising that early reliance on historical texts dating from that later time, plus eighteenth- through-twentieth-century travel experience, lent to most interrogations of that alluvial past the persistent presumption of a largely flat, uniform,

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surface protruding slightly above the newer alluvial plain—like a floating turtle’s back, protruding above calm water.

desertic-steppic plain, devoid of the meanest resource save silt and shrub, transited by its two great rivers (such as Nissen 1988: 2).[11] But mounting climatic and geomorphological evidence requires a reconsideration of that terrain during the fifth–fourth millennia BCE, and thus of the social developments arising within it. During the thousand years of the Uruk-period expansion, a rivers-through-the-desert image[12] simply does not adequately characterize conditions on the ground as we now understand them. We cannot wrest the origins of alluvial Mesopotamian cities from an irrigated version of the modern landscape, because they grew instead on the borders and in the heart of vast deltaic wetlands. These were in part derived from Euphrates floods, supplemented by rainfall, but the greatest portion of their annual recharge was the result of Tigris outflows. These wetlands served as a massive sponge, absorbing water during flood seasons, and releasing it to soil moisture and ground water during the remainder of the year.

Guillermo Algaze (2001) is among the first to consider significant consequences of a fundamental reconception of the ecology of the southern alluvium

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[11] Innumerable overviews of the broader geologic and geographic settings comprising greater Mesopotamia have been published over the past several decades (e.g. Redman 1978, Adams 1981, Nissen 1988). More recently, these have been reconsidered in light of new evidence regarding rising sea levels commencing in the mid-Holocene (Sanlaville 1989, 1996, and 2003; Postgate 1992; Lambeck 1996; Geyer and Sanlaville 1996; Potts 1997; Aqrawi 1997, 2001; Kouchoukos 1998; Verhoeven 1998; Pollock 1999; and especially Wilkinson 2003). See Chapter Three.

[12] E.g., Jacobsen 1957: “Settled human occupation, accordingly, is closely tied to rivers and canals and only occurs along them” (96); “These cities with their surrounding villages were limited essentially to points along two separate lines…Between the two lines, effectively separating them, lay open desert…” (98).

during the Uruk period urbanization. He hypothesizes that:

> "geography, environment, and trade can be seen as the most important factors helping shape the initial nature of social complexity in the Mesopotamian alluvium," (199) in that "the unique ecology and geography of the alluvial lowlands...gave Mesopotamian societies important advantages in agricultural productivity and subsistence resilience not possessed by contemporary polities on their periphery," (204–205) spurring a "synergistic cauldron" (207) that created "high levels of social and economic differentiation, promoted unprecedented population agglomerations and selected for the creation of new forms of social organization and technologies of social control." (208)

Taking as his point of departure findings presented in Chapters Three and Four of this study, his model laudably reassigns marshes from the "wasteful" to the "useful" side of the land classification equation, focusing in particular on transportational advantages and subsistence resilience.

We can now reconstruct with greater precision than was available to mid-twentieth century theorists the paleogeography of the lower Mesopotamian alluvium during the formative Chalcolithic and Early Bronze periods, and offer a view at a regional scale inaccessible through single-site excavation. I also hypothesize the essential nature, not merely of *water,* but of *wetlands*, in supporting and shaping the complex social institutions that underlay urbanization in southern Mesopotamia, arguing that, as for fifth–fourth millennia BCE Egypt (Hassan 1997; Hellier 2000),[13]

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[13] Faunal analyses at deltaic (Maadi, Buto, and Merimde) and lacustrine (Fayum) sites challenge earlier exclusion of a role for the lower delta in the rise of social complexity in Egypt. During the sixth and fourth millennium BCE, pluvial conditions prevailed, and the Fayum Depression/Lake (Birket) Qarun was connected to and received Nile flood overflow. Thickly vegetated shallows were interspersed with thick reed beds and tree-lined shores. Nile catfish (*Clarias* sp.) were the most common fauna represented in both Fayum B (6170–5670 BCE) and Fayum A (4341–3020 BCE) remains. At

broad processes can be discerned that require a third pillar to be added to the agro-pastoral subsistence dyad so vigorously investigated during the twentieth century. However, I wish to stress the role of littoral propinquity,[14] not in originating (or improving) agriculture, but in establishing the territorial precursors to later governing institutions. In the concluding chapter, I attempt to understand what "new forms of social organization and technologies of social control" across that now visible wetland might be, in an era when an urbanized elite, with the will to redefine productivity toward its own ends, was first emergent. That is, I interrogate the origins of the wasteful/useful dichotomy itself, arguing that it *expresses* principles of rank, authority, privilege and landscape organization that define social complexity, and therefore cannot precede them.

In this introductory chapter, I have briefly reviewed an intellectual tradition that, over the past century, has limited the ways that early civilizations of Mesopotamia were investigated and understood.

Fayum B these also included significant proportions of migratory waterfowl (Brewer 1989: 28). The Nile Neolithic/Predynastic transition can be broadly characterized by an accumulation of fishing technologies, from opportunistic clubbing of catfish stranded in seasonal pools, to shore netting of *Tilapia*, to deep-water angling/harpooning of Nile perch, especially in Upper Egypt. In the delta, while the later Fayum A saw the introduction of ovicaprids, in only one case did this constitute a significant proportion of remains—and then only *after* a full complement of fishing technologies had been developed elsewhere (Eiwanger 1984; Boessneck, von den Dreisch, and Ziegler 1989).

[14] In the broad sense including all borderlands between land/water, freshwater/saltwater, and steppe land/marsh.

In Chapter Two, I discuss the role of imagery in archaeological research design, and address tendencies to conflate *visibility* of archaeological data with *visualizations* of the past. I distinguish physical *terrain* from ideological *landscape* as objects of investigation, and discuss means for relating changes in both through time.

In Chapter Three, using satellite imagery to integrate geomorphologic and paleoclimatic evidence, I examine the Tigris-Euphrates delta, identify courses of the Tigris and Euphrates rivers, locate the Persian Gulf head, and reconstruct terrain surfaces as they may have appeared between five and six thousand years ago. I argue that much of the archaic alluvial landscape of southern Iraq consisted in large part, not of desert or steppe, but of wetlands, and that this finding requires a comprehensive reassessment of southern Mesopotamian resource management strategies and their role in emergent complex polities.

In Chapter Four, I review assumptions about Mesopotamian cultural ecology, present material indications for settlements, waterways and associated terrain features, and discuss archaeological and ethnographic evidence for interactions between human and natural processes. In the light of excavation data,[15] I argue that a significant component of the resource basis for precocious, large deltaic towns was probably that derived from surrounding marshland; and conclude that only following specialization and integration of, not two, but three, productive economies: agricultural/horticultural, pastoral/husbanding, and wetland, could and did Mesopotamian urban civilization

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[15] From Uruk, ‘Oueili, Eridu, ‘Ubaid, Ur, and others, discussed below.

flourish.

Finally, in the concluding chapter, I consider how the landscape vision at the dawn of the twentieth century blinkered the view of colonial administrators, in ways that had a lasting impact on reconstructions of early urban life in the lower alluvium—and contrast this with ways that wetlands may have been seen by proto-urban elites five millennia earlier, as they undertook their urbanizing projects that eventually converted socially unranked, undifferentiated wetlands, into alienated, ranked, extra-urban hinterlands.

II. VISIBILITY AND VISUALIZATION: CONSTRUCTING LANDSCAPES

> [C]ountless subjects…come to one's mind where connections between archaeology and landscape are involved. These subjects are precisely at the heart of all our research because any archaeological investigation aims at reporting the close relations linking man and nature, at any given time or place. These relations are the essence of culture itself, and being an ever-changing reality their main impact is changes in landscape.
>
> ———Jean-Louis Huot, 1999

> It is impossible to describe regimes independent of the spatial order they created: the regions they united, the cities they built, or the architectural monuments they raised. However…[i]n recent years, several investigations have given a more prominent role to the organization of space in the constitution of political authority, pointing out ways in which particular spatial forms were instrumental in establishing power and legitimacy.
>
> ———Adam T. Smith, 1999: 45.

Too often, the study of the ancient past is viewed as the sole province of excavation. That is, too often, while air photographs are used to illustrate "a site," their potential value as archives of ancillary data is ignored. Or, they are viewed only as utilitarian road maps; as mere aids to navigation on the ground. Only rarely is aerial survey included as an integral part of archaeological research design, where it occupies a unique niche among remote sensing strategies. At the level of technique, in this chapter I discuss some of the mechanics of making archaeological evidence visible within the photographic record. The methods for performing this analytic task are hardly new, but they have entered into common archaeological practice only haphazardly, and therefore bear repeating.

At a more theoretical level, air and satellite photographs can also be used to help visualize archaic landscapes. Any integration of many strands of visible evidence to form a coherent description is a kind of visualization; a creation of an image of the past. Remotely sensed imagery can be used to visualize terrain in a literal sense, as by constructing a three-dimensional model. It can also be used to help define the boundaries within which point data, such as samples from an individual bore hole, or one text from an individual archive, may be representative of some past physicality. In the subsequent chapters of this dissertation, I undertake a kind of analytical visualization that I call a *comprehensive landscape reconstruction*, and in this chapter I also discuss the method, and the limitations of the method, I have used to do this.

Archaeological applications for remote sensing methods, and especially imaging methods, have developed in spurts following the global conflicts, hot and cold, of the twentieth century.[16] The evolution of archaeological applications for remote sensing in general, including air photography, has gone hand-in-hand with the evolution of research questions, approached with new capabilities gained from national (and especially defense) technology transfers. Broadly, evolving research agendas can be characterized as intensive, designed to gather ever-more-detailed

[16] Colwell 1997 provides a brief history of aerial photography, and Schorr 1974 summarizes the earlier history of photographic and emergent digital imaging applications for anthropological and archaeological purposes. Deuel 1969 provides a history of "aerial archaeology," an overview updated by Riley 1987: 11–16, Stoddart 2000: 75–78, Renfrew and Bahn 2001, and Bewley 2002. Recent regional updates include: Avery and Graydon 1992: 272–274; Ebert 1997: 556–560 (United States); Darvill 1996, Gojda 1997, Wilson 2000: 16–22 (Britain); Kennedy 1998a and b, 2002 (Middle East); Deletang and Agache 1999 (France); and Heller 1999 (Germany).

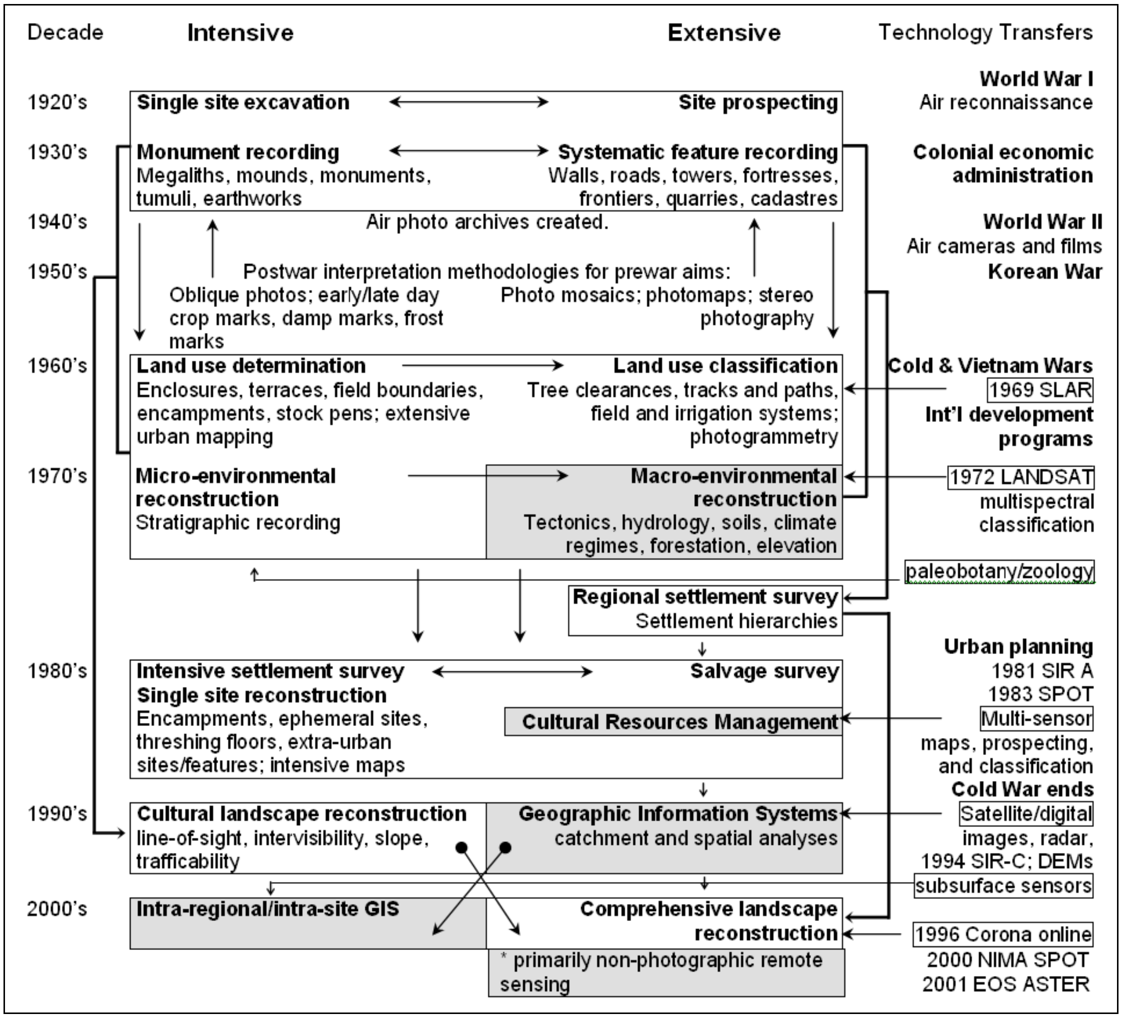

Figure 3: Archaeological Applications of Aerial Photography.

information about individual sites and their adjacent locales, and extensive, aiming to elucidate systems and systemic changes across regions (Figure 2). Photographic reconnaissance was an outgrowth of World War I-era aircraft, camera, and film developments, and the war years saw the earliest attempts to capture images of single sites.[17] Some discoveries were made by pilots patrolling the French countryside; back

[17] The airframes and cameras developed for use during the First World War followed balloon reconnaissance during the American Civil War, and the technical evolution of photographic cameras themselves descends from the *camera obscura*. It is not without

home in Britain following the Great War, efforts intensified toward recording noteworthy megaliths, mounds, monuments, tumuli, and earthworks.

In the Middle East, competition for control of Ottoman lines of communication lead to a spate of French aerial reconnaissance and mapping across the Levant, Syro-Anatolia, and northern Iraq (following the Damascus–Palmyra–Mosul and Aleppo–Baghdad road and railways), with archaeological prospecting as an adjunct activity (Table 1). German pilots searched over wide areas for archaeological remains in Turkey (Deuel 1969: 15). The British relied heavily on air power in the bogged-down southern Mesopotamian Theater, and south of Baghdad began air mapping as early as 1915 to supplement ongoing ground-based cartography conducted by the Survey of India. British cartographers faithfully recorded even miniscule settlement mounds, as they were often the only registration and navigation points available in a terrain otherwise utterly without visible relief. They also recorded spot elevations, marshy areas with seasonal flood depths, ancient tracks, ruins, and archaic canal systems large enough to be an impediment to cavalry. Unfortunately, none of the original air photographs survive, and the heavy glass photographic negative plates were destroyed

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irony that optical physicists trace their intellectual roots to Abu Ali Hasan Ibn al-Haitham (westernized as Alhazem, or Alhacem), 965–1040 CE, of Basrah. Preserved in Latin translation, Alhazem's great work on optics, *Kitab al Manadhir* (*Kitab-at-Manazir*) (Latin *Opticae Thesaurus; De Aspectibus*), which greatly influenced Roger Bacon and his successors, speculated on the physical nature of light, theorized physical phenomena like shadows, propagation, optical illusions, reflections, and refraction, attempted to explain binocular vision, and described experiments with the *camera obscura* (Smith 2001).

Table 1: Air Photo Surveys and Archaeological Studies, Middle East and North Africa

Image Dates	Authors	Countries	Projects
1917–19	**UK RAF**	**Iraq, Iran**	**Map series TC: Fao–**
1922–28		**Jordan, Syria**	**Baghdad–Aleppo**
1917	Beazeley	Iraq	Samarra ruins
1917	Wiegand	W. Turkey	Greco-Roman cites
1917–18	*Deutsches-Türkisches Denkmalschutz*-Falk	Israel-Negev, Jordan, Turkey	Monument inventory
1923–14	A. Kennedy	Israel	
1924–28	RAF	Israel, Jordan	Ancient cities, fortresses
1925–39	Poidebard	Jordan, Syria, N. Iraq	Roman eastern frontier
1927	Maitland	Arabia	Hill fortresses
1927–39	Glueck	Israel, Jordan	Mounds, roads
1928	Crawford	Jordan, Syria, N. Iraq	
1929	Englebach	Egypt	Pyramids
1930	Hall	Iraq	Ur, Eridu, ‘Ubaid ruins
1935–38	Schmidt	Iran	Ancient cities
1938–39	Stein	Jordan, Syria, N. Iraq	Roman eastern frontier
1941	**UK Royal Engineers**	**Iran, Iraq**	**Map series K701**
1949	Baradez	Algeria	Roman military posts
1950	Reifenberg	Israel	
1953	**Hunting Aerial Survey**	**W. Jordan**	**Mapping**
1954	Caillemer & Chevallier	Tunisia	Roman land centuriation
1955	Bradford	Turkey	Gordon environs
1961–62	**KLM/Hunting AS**	**Iraq**	**Agricultural Development**
1967	Kedar	Israel-Negev	Water collection systems
1968	Oates	N. Iraq	Romans in Assyria
1971	Evanari, Shannon, & Tadmor	Israel-Negev	Roman/Nabatean irrigation
1972–81	Adams, Wright	Iraq	Settlements, irrigation
1977	**IAF**	**Israel**	**Survey of Israel**
1977	North and Svehlak	North Africa	Roman city; qanats, farm
1982–00	Kennedy, Bewley, Comfort	Jordan, Turkey	Roman cities, routes, camps
1982–83	Riley, Betts	Israel	Neolithic enclosures, camps
1984–89	Barker, Dorsett	Libya	UNESCO valleys survey
1985	Gory	Jordan	Petra-environmental study
1990	Kennedy & Riley	Israel, Jordan, Syria	Roman desert frontiers
1990–92	Riley, Isaac, & Gichon	Israel	
1992	Summers	Turkey	Iron Age city Cever Kale
1993–2003	Wilkinson, Ur	Syria	Bronze Age roads and tracks
1993–2003	Wilkinson	Syria	Bronze Age hinterlands
1998–2002	Kouchoukos	Iran	Land cover classification
1964–72 (97)	**U.S. CIA**	**All**	**CORONA/Arms Control**
2001	Pournelle	Turkey	EBA hinterlands modeling
2002	Donoghue, Philip, Galiasatos	Turkey-Orontes	Settlements, fields, irrigation

Sources: See note 16. **Bold** text indicates comprehensive aerial coverage.

to save the expense of shipping. The resulting 1917–24 map series nonetheless remains an invaluable aid to photographic interpretation, especially south of Baghdad.

North of Baghdad, after the armistice, under the British Mandate (and related to economic administrators' interests in cataloguing and assessing resources and resource development requirements) the inter-war years saw systematic attempts to record Roman administrative features such as walls, roads, towers, fortresses, frontiers, quarries, and field systems. Use of aerial photography for reconnaissance and bomb damage assessment during the Second World War spurred further development of aerial camera systems and high-resolution films, aerial photographic archives, photographic techniques for capturing detailed ground evidence of disturbance, movements, and trafficability, and stereo photography for terrain relief assessment—as well as a large cadre of personnel trained in these tools and procedures. While the research agenda itself seemed frozen, for a postwar decade these new methodologies were incrementally and systematically applied to intensive single-site and earthworks prospecting and recording on the one hand, and extensive searches for (especially Roman) imperial systems on the other.

This impact was immediate in Britain (where techniques inherited from the war department were institutionalized at the Cambridge Air Survey) but delayed in America (by growing strategic concerns in the Soviet Union and Korean peninsula, which both spurred new airframe, camera, and film development, and hindered systems declassification and demobilization of trained personnel) (Heiman 1972). First fruits of these developments appeared during the early 1950s, with the introduction for civilian use of systematized photographic interpretation keys and technical aids (Rowe 1953). Although by the late 1950s, British contractors in Iraq relied heavily on aerial mapping and survey (especially for agricultural engineering), except for the occasional illustrative photo of an excavation, the resulting photographs were not put to use in archeological settlement studies for another decade.

Livingston's 1964 history of military mapping cameras marks the entry of Korean-war era technology into the unclassified arena. Cold War rural development schemes aimed at countering insurgency and promoting a green revolution in the underdeveloped world spurred intensive studies of land-use, and used air photos to examine "traditional" field terrace and irrigation systems. Vietnam-era side-looking airborne radar (SLAR) technology debuted in the anthropological realm with Viksne's reconnaissance of Panama (Viksne 1970). Anderson 1971 marks the introduction of land use classification to problems within the United States—a practice accelerated by the 1972 release of publicly available multispectral LANDSAT imagery. Among the pioneers of specifically aerial photographic usage in archaeology, the works of Agache and his students 1962–84 chart the evolution from site prospecting to systematic regional mapping in France. The lengthy subtitle of Paul Kosok's *Life, Land, and Water in Ancient Peru*, published in 1965, neatly summarizes the state of extensive aerial archaeology to that date. The work, based upon two decades of aerial survey by Kosak and his predecessor Gordon Willey (Willey 1953), provides a richly illustrated "*Account of The Discovery, Exploration, And Mapping of Ancient Pyramids, Canals, Roads, Towns, Walls, and Fortresses*" throughout the entirety of coastal Peru. Among intensive applications, the stunning, unprecedented mapping program at Teotihuacán in the Valley of Mexico, published in the 1960s, stands out. Rene Millon, in collaboration with George Cowgill and Bruce Drewitt, used thousands of air photographs and meticulous ground survey to comprehensively map the city, including the urban core, its sprawling suburban neighborhoods, and surrounding hinterlands (Millon and Cowgill 1973). This work was ecologically contextualized by a rigorous survey of the Valley of Mexico (Sanders, Parsons, and Santley 1979). Thus, archaeologists had, during the first three quarters of the twentieth century, adopted and adapted aerial photography to: (1) find individual sites or features such as a single tell or monument; (2) perform comprehensive recordings of feature sets within a region, such as roads, fortresses, *limes,* etc.; (3) conduct hinterlands surveys accompanying major excavations; and (4) expand regional settlement mapping.

British and European development of intensive archaeological applications for aerial photography went hand-in-hand with New Archaeology processual approaches, and development of and debate over random versus full-coverage survey sampling techniques (Fish and Kowalewski 1990). However, agricultural development-driven emphasis on land use classification also spurred application of air photography to macro-environmental reconstruction. In alluvial Mesopotamia, a landmark series of extensive settlement surveys was conducted with the aid of aerial photography (Adams 1965, Gibson 1972, Adams and Nissen 1972, Adams 1981 and Wright 1981). For the first time anywhere in the Middle East, these attempted to situate settlement schema first identified by aerial prospecting, then confirmed and dated by ground survey, within long-term processes of cultural ecology. Adams and his collaborators used imagery not merely to “find sites,” but as an aid in examining (5) landscape engineering (especially irrigation systems) and (6) anthropogenic interactions with geomorphology (such as soil salinization and river channel deflection).

The advent of commercially available SPOT imagery in 1983—the first digital imagery product of sufficiently large scale (1:25,000) to aid urban and infrastructure construction planning—dovetailed with the consequent growing need for archaeological salvage survey and cultural resources management (see Avery and Berlin 1992: 269–297; Ebert 1997). The Cold War's end in the early 1990s added to this toolkit a series of radar mapping technologies (such as Shuttle Imaging Radar, or SIR), much refined since their first experimentation in the 1980s (Clapp 1998). This period saw the migration into the archaeological realm from military and industrial sectors of geographic information systems (GIS), digital imagery analysts, and spatial analysis software related to these efforts.

Increasing public access to satellite technology for urban planning, agricultural development, and hydraulic engineering had unintended consequences for the preservation of photographic images. In an alarming letter to the readership, editors of the British archaeological journal *Antiquity*, since the early twentieth century the premier showcase for "aerial archaeology" and later the European school of landscape archaeology, in 1999 decried the impending closure of the Cambridge Aerial Survey (CAS). For nearly a century, first assisted by the British Air Service and later using its own aircraft, the CAS pioneered techniques and best practices for systematically recording archaeological sites, monuments, agricultural relicts, and other landscape features using aerial photography. Over the decades, the CAS compiled an archive of photographs numbering in the hundreds of thousands. Detractors of the program argued against its expense, viewed its research agenda as outmoded, and asserted that commercial digital satellite imagery had made (or would in any event make) aircraft an obsolete platform for image procurement. CAS supporters, defending a middle ground between high theory and ground-based materials analysis, countered that satellite imagery was simply neither as detailed nor as flexible as air photography, and that ending the program just as new technologies arrived on the scene was not only a waste of hard-earned patrimony, but vastly premature (Bewley 1999; Stoddart 2000).

Air photograph collections, gathered at huge public expense for immediate, non-archaeological purposes, have a sad history of being viewed as outdated, outmoded, difficult to preserve or work with, and therefore of little value. The fate of O.G.S. Crawford’s valiant efforts to preserve exquisitely-detailed 1920s RAF coverage of vast tracts of the Middle East—an expensive proposition, requiring transport and storage of hundreds of heavy wooden crates packed with foot-square glass negative plates—is all too typical. In his autobiography, Crawford wrote:

> one of the things that needed doing most was to rescue from destruction the air photographs taken by the Royal Air Force in the East both during and after the war. I had made a fruitless attempt to prevent the destruction of negatives taken over Gallipoli and Troad—a region closed both before and since to such work…I was told that…a certain person…had buried…some tens of thousands at least, in a deep hole at Farnborough. I made other intermittent attempts to rescue for archaeology and geography negatives which were no longer required for service purposes. The only one which succeeded was that which I carried out myself. The proposal was to collect negatives at the three chief centers in the Middle East—Baghdad, Amman, and Heliopolis—bring them back to England and hand them over to some institution that would house them, make prints from them…and…add to the collections….Official sanction was given to the proposal, and I was also promised free RAF transport after reaching Baghdad both in Iraq (for reconnaissance) and from Baghdad to Cairo via Amman…The

> problem of finding a home for the negatives was a difficult one. The Ordnance Survey was ruled out because it was concerned only with Great Britain. I discussed with Hinks, Secretary of the Royal Geographical Society, the possibility of the Society housing them, but there were objections to this and we agreed it was not practicable; moreover it is probable that the RAF would not allow them to pass into 'private' custody. A government or service department can destroy its property, but it cannot present it to the public which has paid for it. Finally, the British Museum, through its Director, Sir Frederic Kenyon, agreed to take charge of them….On December 6th I left by train for Port Said, where I embarked on a Dutch liner for Marseilles, reaching Southampton on December 15th. I had a portentous amount of luggage, most of it consisting of wooden boxes of air-photo negatives which I had brought by air from Baghdad and Amman. Thanks to facilities granted by the RAF these were shipped from their private wharf at Port Said and disembarked later at Southampton…Thence they were transferred to the British Museum, where they resided unused for nearly a quarter of a century. They are now in the Institute of Archaeology….I had hoped to make some arrangement by which archaeologists primarily concerned with the East (which I was not) would be able to make similar trips at regular intervals, to collect such negatives as the RAF no longer required. Very many of these were of archaeological and geographic value, but the RAF rule was that they should be destroyed every six months or so. The rule was not all strictly observed; many of those which I salvaged were far older. But it seemed a great waste of good material, and I wanted to save it. The onus lay upon others to follow up what I had begun. I tried to arouse their interest but in vain. The negatives remained in the charge of the RAF and a great opportunity was lost. (Crawford 1955: 189–190, 199–200)

What Crawford's efforts had preserved became fragmented among a series of archives. What remains for Iraq are primarily presentation photos of old cities and large excavations (Table 2). Likewise determining holdings to be of insufficient value to justify their continued maintenance, in 1989 Hunting Surveys archivists discarded rare KLM photo mosaics. Thus, despite expensive efforts to collect comprehensive air photo coverage of Mesopotamia, repeated over a forty-year period by governments of three nations (Britain, Germany, and Iraq), only dislocated fragments remain, mixed

Table 2: Archived Air and Ground Landscape Photographs of Mesopotamia

Dates	*	Qty	Description	Collection or Expedition
				University of Pennsylvania Museum, Philadelphia: photographic archives
1920s	A	23	Rayq, Rowanduz, Shatra (Mosul), Erbil, Baghdad, Babylon, Nippur,	Hilprecht (1888–1910); Nippur (1889–1900; 1940–52), Ur (1922–34), and Fara (1931) expeditions.
1888–1952	G	~3000	Lantern slides, glass negatives, scrapbooks, boxed photographs	
				Imperial War Museum, Lambeth, London: Photographic Archives
1915–19	G	1409	New prints: Basrah–Baghdad campaigns	Q-series albums.See Table 16.
1928–36	A	60	Kurdistan old cities; Samarra, Hit, Baghdad, along Tigris	Combe; Mesopotamia Env. 21; Scrapbook 56737–852.
				British Museum, London: Study Room
1926–30	A	2	Photo mosaic showing levee detail at Ur	Hall expedition
				British National Library, St. Pancras, London: Oriental and India Office
1858 1903 1910–26	G	~100	Albums: Baghdad, Nineveh, Babylon, Karbala, Diyala, Mosul, Nasiriya, Ashur; Beirut–Qetta	Curzon, Hall, Lorimer, Ludlow, Parke, Ross, Zetland, Svoboda, Teague-Jones, Thomas
1915–19	G	63	Album: Tigris, Basrah–Kut; Birs Nimrud	John Cameron: Photo 350/3
1917	G	58	Albums: Lower Karun, Tigris, & Euphrates	Ltc. Frederick Marshman Bailey: Photo 1083/38–39
1918–19	G	26	Album: Basrah to Baghdad via Tigris	Maj. Charles Denis Balding: Photo 498 v2
1928–29	G	~1000	Ubaid, Eridu, Ur, Senkereh, Warka, Ctesiphon, Nineveh, Samarra, Jebel Sinjar, Erbil, Dura-Europas, Palmyra, Tyre, Jerash, Palestine, Orontes, Seleucia, Antioch	Sir Aurel Stein: 2nd Middle East Tour, albums 12–16; 58–74
				Public Record Office, Kew, Surrey
1916	A	Few	Kut on last day of siege	AIR 1/733: 186/1
1917	A	9	Mosaics: Baghdad, Kufah, Najaf, Mosul, Hilla, Karbala; Kasvin, Kermanshah	AIR 1/2359 (HQ #1st Wing Mesopotamia)
1918–19	A	31	Macedonia, Palestine, Aleppo, Damascus, Kirkuk, Tikrit, Samarra, Felluja, Babylon, Baghdad; along Zab, Diyala, and Tigris; mosaics of wadi/river systems.	CN 512 Part 1/2/3 (RAF 16th Wing, Salonika (Palestine)
1918	A	97	*Notes on Aerial Photography Part II: The Interpretation of Aeroplane Photographs*	AIR/10/1001
1918	A	15	Photographic Interpretation Keys	AIR/432/15/260/26
				King's College, London: Liddell Hart Center for Military Archives
1933–37	A	67	Zakho, Erbil, Kirkuk, Rowanduz, Hatra, Nineveh, Shergat, Sulaimaniya, Mosul, Samarra, Baghdad, to n. frontiers; log books	Fitzgerald Lombard Slade
				Cambridge University Library: Department of Manuscripts
1924	A	31	Baghdad, Babylon, Hilla, Ctesiphon, Rowanduz, Mosul	Templewood
				National Archives of Scotland, Edinburgh
1926–28	G	27	Album and negatives: Zab, Mosul–Hatra,	Stewart Peter GD391/68 /75
				German Archaeological Institute, Berlin: Oriental Division
	G	97	Uruk environs	Warka (1912, 1928–40, 1954); van Ess (1984–89)
				Bundesarchiv Koblenz
1923–34	A	5	Tigris, Habbaniya, Arabia	Irak 222;
1923–25	G	13	Albums: Tigris, Mosul–Kirkuk	Bild 1/6/367–68

* A=Air G=Ground

among somewhat more coherent collections of ground photography.

Meanwhile, in Europe and especially Britain, the expansion of intensive survey strategies to the “landscapes” surrounding single or clusters of sites was aided instead by ever more refined aerial photographic acquisition and interpretation protocols. Only photography offered sufficiently detailed resolution to aid studies of encampments, threshing floors, various extra-urban pot drops, and other ephemeral features. Unlike the extensive emphasis of a growing cadre of American GIS experts, still in essence engaging the research questions and protocols of the 1960s and 1970s—driven in part by the aims and limitations of then-available digital imagery—the British school and its followers were the first to integrate intra-site examination with intensive examination of those sites’ local landscapes (such as Bradley 1998; Riley 1987; Darvill 1996; Stout 1997; Fowler 1999). Using the terms and theories of cultural geography, photographic interpretation practices expanded to include inter-site visibility, access, and relation to local terrain features. The British school endeavored to use imagery, not merely to locate ancient sites and features, but to understand the cognitive engagement of ancient inhabitants with the world around them.

Thus, CAS—and other national programs in France, Germany, and the Netherlands (Bewley and Raczkowski: 2)—is intimately connected to the theoretical underpinnings of “landscape archaeology,” in two senses of that term. Both practices of and protocols for systematically describing physical terrain and its geomorphology, including the taphonomy of extra-urban sites and features (such as fields, gardens, and irrigation systems) (Miller-Rosen and Weiner 1994; Miller-Rosen 1997; Miller and

Gleason 1994; Wilkinson 1990–98), and hypotheses regarding relationships between archeologically detectable phenomena and cognitive landscapes (Ashmore and Knapp 1999; Morris 2000) have been developed alongside aerial investigations of the past.

This is most certainly the wrong time to end such programs. Given the considerable advances in both techniques of and interpretive protocols for intensive archaeological applications of aerial photography since the 1970s, the 1997 release of CORONA satellite photography sparked a burst of new interest in photographic interpretation among archaeologists. CORONA declassification provides low cost, near-universal coverage, at constant scale and quality, imaged for the most part before massive agricultural development schemes obliterated surface features, making available for the first time a consistent, comparable, global data set. However, we lack a body of methodology for CORONA use in archaeological investigations. [18] The obvious starting points are the now decades-old techniques for using air photography, the essentials of which I will now review.

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[18] Available to the public through the United States Geological Survey (USGS) Earth Resources Observation Systems (EROS) Data Center (USGS 1997); see Satellite Images Home: <http://ask.usgs.gov/satimage.html>. Comprehensive discussion, links, and references are at Galiatsatos 2002. Generally referred to by the overarching program name "CORONA," declassified photographs are the product of seven different camera series/film systems imaged between the years 1960–1972. Only those from series KH4B, taken between 1968 and 1972, offer near-worldwide coverage at sub-two-meter resolution, roughly comparable in image quality to medium-altitude air photography. For maximum resolution, CORONA KH4B imagery requires either (up to twenty-fold) photographic enlargement from film, or specialized film digitization methods. For a fact sheet see: <http://ask.usgs.gov/satimage.html>. To search for, preview, or order images, see: <http://edcsns17.cr.usgs.gov/EarthExplorer/>. For a technical guide to CORONA products and missions, see: <http://edc.usgs.gov/Webglis/glisbin/guide.pl/glis/hyper/guide/disp>.

A number of elements are used consciously or unconsciously by photographic interpreters to distinguish distinct features or qualities in a photograph. However, "the fundamental element of photo interpretation is tone or, more precisely, the difference in tone" (Teng et al. 1997: 51). In panchromatic (black and white) photographs, tone (including color, hue, intensity, saturation) is represented by varying densities of silver grains in a photographic emulsion. By perceiving differences in tone, at increasing levels of abstraction interpreters classify objects by: geometry (size, shape, and height), the spatial arrangement of tonal boundaries (shadow, texture, and pattern), and context (*site*, or geographic location; *association*, or the degree of proximity and connectedness; and *time*, or the temporal relationships established from sequential or multiple coverage). While geometry, shadow, texture, and pattern are the primary means by which discrete features or sets of features are recognized; context vastly narrows the range of choices from which such identifications may be made. To accurately assess context, interpreters must become familiar with the photographic rendering of geology, soils, vegetation, hydrology, structures, and cultural features in the region of study. To accurately assess tonal variance, they must also understand the technical qualities of the films, emulsions, papers, optics, digitizers, image processors, etc., used to produce the image studied—as well as how the eye perceives and the brain processes it (Avery and Berlin 1992; Teng et al. 1997).

The literature on photographic terrain analysis is vast (see Collins 1998),[19] but

[19] The canonical *Manual of Photographic Interpretation* (MPI) provides a brief overview of wind-laid and fluvial landforms (Way and Everett 1997: 147–60), as well as chapters on the interpretation of soils (Belcher et al. 1997), vegetation (Murtha et al.

can be broadly subdivided among four foci: (1) geology (land forms, hydrology); (2) topography (slope, trafficability, line-of-site); (3) land cover classification (vegetation, soils, surface qualities, land clearance); and (4) constructed features (lines of communication, infrastructure). Archaeological photographic interpretation has until recently for the most part focused on the latter of these categories, and, rather than proceeding from a solid foundation in the former three, sought to extend examinations of structures in a familiar (European) setting to analyses of similar structures in less familiar (such as Middle Eastern) ones. In this study, I instead began with a thorough examination of photographic terrain analyses of arid alluvial settings and, wherever possible, the Tigris-Euphrates delta. From these, I built CORONA photographic interpretation keys for specific terrain attributes, discussed in the next two Chapters.[20]

Early on, practitioners of “air archaeology” used subtle tonal variations that delineated edges and boundaries to identify ruined architecture and other features that

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1997), and wetlands (Tiner 1997), although examples are limited to the United States. Lueder 1959 includes superior treatment of surface drainage, erosion features, fluvial, marine, lacustrine, and aeolian landforms, and an exceptional discussion of gray tone interpretation as related to soil moisture, with many examples from the Middle East. Zuidam 1986 also provides good discussion and examples for analysis of tone, pattern, and texture (55–60), coastal and deltaic landforms (Chapter 18), and aeolian landforms (Chapter 19). For fluvial landforms, see also Baker 1986. For coastal landforms and sabkhas, see USDMA 1996, module 2. On deltaic formations, see Coleman, Roberts, and Huh 1986; (especially bird’s foot deltas) USACE 2002: 8–13, Miller 1961: 161.

[20] Photo interpretation keys “are based on the principle that the same terrain attribute is depicted similarly if it exists under approximately the same environmental conditions. Thus discrimination between terrain units may be based on superficial, photographic, and field characteristics, which imply a characteristic hydrologic, pedologic, and lithologic composition. Well-defined aerial photographic keys will result in rapid interpretation and classification of the survey area.” Zuidam 1986: 5.2.

were either no longer visible from ground view, or that were too geographically remote to be reached by other means. The visibility of otherwise imperceptible topologic variation could be enhanced by photographically recording the shadows cast by sunlight at very low angles; that is, just after sunrise and just before sunset (Scollar 1965: 18). Shadows and highlights also change seasonally, due to changing sun angle (Deuel 1969: 46–7), and may be further exaggerated after light snow (Riley 1987: 21). Even without relief variation, soil marks might be visible from the air due to variant organic or mineral content, soil moisture, or temperature (Deuel 1968 49–50), attributes exaggerated by frost or damp (Riley 1987: 17–26).

Under vegetation cover, these factors combine to make crop marks, that is, photographically detectable variations in color, height, and rates of growth, especially in grain crops and grasslands (Riley 1987: 27–35). Aerial archaeologists understood early on that crop growth was stunted over wall remains, but enhanced over moist, organic-filled ditches, creating shadow marks in young stands that neatly mapped sites invisible at the surface. Several researchers documented the principles of negative and positive growth for detection of walls and ditches, by crop and growth phase (Scollar 1965: 29; Dassie 1978: 24–25), in order to create calendars, by crop type, of optimum times to image fields (Scollar 1965: 18).

In Europe, geophysical investigations of soil color and composition, mobility (due to bioturbation and mechanical transport), moisture permeability, and thermal properties under frost and snow lead to complete analyses of visible water balance impacts, related to soil type, on the spectral properties of vegetation (Scollar, Tabbagh, Hesse, and Herzog 1990: 33–76). Such research opened the way to using air photography for wider-area landscape investigations, and the addition of thermal sensing across regions (Scollar et al. 1990: 591–635). Examination of shadow, soil and vegetation marks in fields abutting standing urban architecture also shows that, even where sites themselves no longer exist, their former contours may by preserved in modern construction foundation alignments (Goguey 1968: 38). Similarly, older regional topography may be preserved in subsequent road networks and field boundaries (Schmiedt 1966). Taken together, these principles have been used to identify and reconstruct agricultural settlements, field systems, and road networks over ever-larger areas (Frere and St Joseph 1983; Wilson 2000 [1982]: 139–61). Riley (1987: 113–26) summarizes their application to studies of early agriculture in Europe and the Middle East. "Integrated approaches" to landscape study (Stoddart 2000: 135–37) interpret archival photographs in light of field walking and targeted excavation, in order to assess where new air cover may be required. This method has been used to make sense of complicated crop marks in former fenlands and alluvial gravel terraces of the Thames Valley (Miles 1983) and Lincolnshire (Coles and Hall 1997), and, in combination with other remote sensing techniques, has become state of the art in Europe (Bewley and Rączkowski 2002).

To build photographic interpretation keys for discrete archaeological phenomena discussed in Chapter Four, I have drawn on studies in the Levant, Syro-

Anatolia, and North Africa (Table 1),[21] as well as Royal Air Force air photographic interpretation keys developed for the Mesopotamian Theater and archive collections of large-scale ground photographs (Table 2).[22] Features with a sufficiently large footprint (such as salinized agricultural zones, massive canals, and the largest urban centers) were also examined on multispectral imagery (SPOT, ASTER, and LANDSAT) that captures thermal and reflectance data outside the visible range (Short 1982; Barisano 1988; Abrams, Hook, and Ramachandran 2002).

The relationship among remote sensing, ground (surface) survey, and excavation techniques in archaeology is illustrated at Figure 3. Broadly, like the research agendas that make use of them, these too can be separated between *extensive* and *intensive* methodologies, based upon areal coverage, resolution, altitude of acquisition, and depth of surface penetration. Extensive remote sensing allows for collection of aggregate data characterizing surface (and in the case of certain radars, shallow subsurface) conditions for entire settlement catchments and across entire regions; that is, at scales greater than one square kilometer. Intensive remote sensing enables collection of particular data about a single archaeological feature and its

[21] See Renfrew and Bahn 2001 (1996): 75–80 for a summary. See Pournelle 2003 for initial results.

[22] See also Lyons et al. 1977–80; Avery and Berlin 1992: 269–74; and <http://www.ebert.com/Bibliography2.htm> for archaeological interpretation of air photography in the arid American southwest. Unfortunately, no study exists for the Colorado River delta.

immediate surroundings, that is, at scales of less than one square kilometer.[23] Generally speaking, satellite imaging falls in the former, and air photography in the latter category—although the best of declassified CORONA photographs (the KH4B series, imaged 1968–72), while nearly world-wide in coverage, provide the (less than two meter) ground resolution of medium altitude aerial photography. KH4B photographs therefore can serve as a unique bridge between point data and other remote sensing findings.

In the Middle East, initial efforts to use CORONA have begun to recapitulate basic techniques and research aims of the previous century (Figure 2), such as recognition of roads and walls using single imagery frames and stereo pairs (Kennedy 1998b). Current GIS systems have also allowed for relatively quick comparison of these to regional catchment analyses, as for Bronze-Age regional roads and tracks in the northern Mesopotamian Jezira (Ur 2003). In the northern portion of the lower Mesopotamian alluvium, Stone (2002) has coupled intensive surface recovery with detailed examination of SPOT and CORONA, in order to reconstruct Old Babylonian irrigation strategies in the vicinity of Mashkan-Shapir (Abu Duwari). Others working in the region continue with better-understood extensive applications of low resolution digital imagery, such as radar-based river levee mapping (Gasche and Tanret 1998), and AVHRR or LANDSAT-based land cover classification (Kouchoukos 1998).

The availability of CORONA now enables systematic extensive application of

[23] While in theory, intensive collection techniques could be repeated across entire regions, allowing “ground truth” in excruciating detail, in practice this is rarely practicable or affordable.

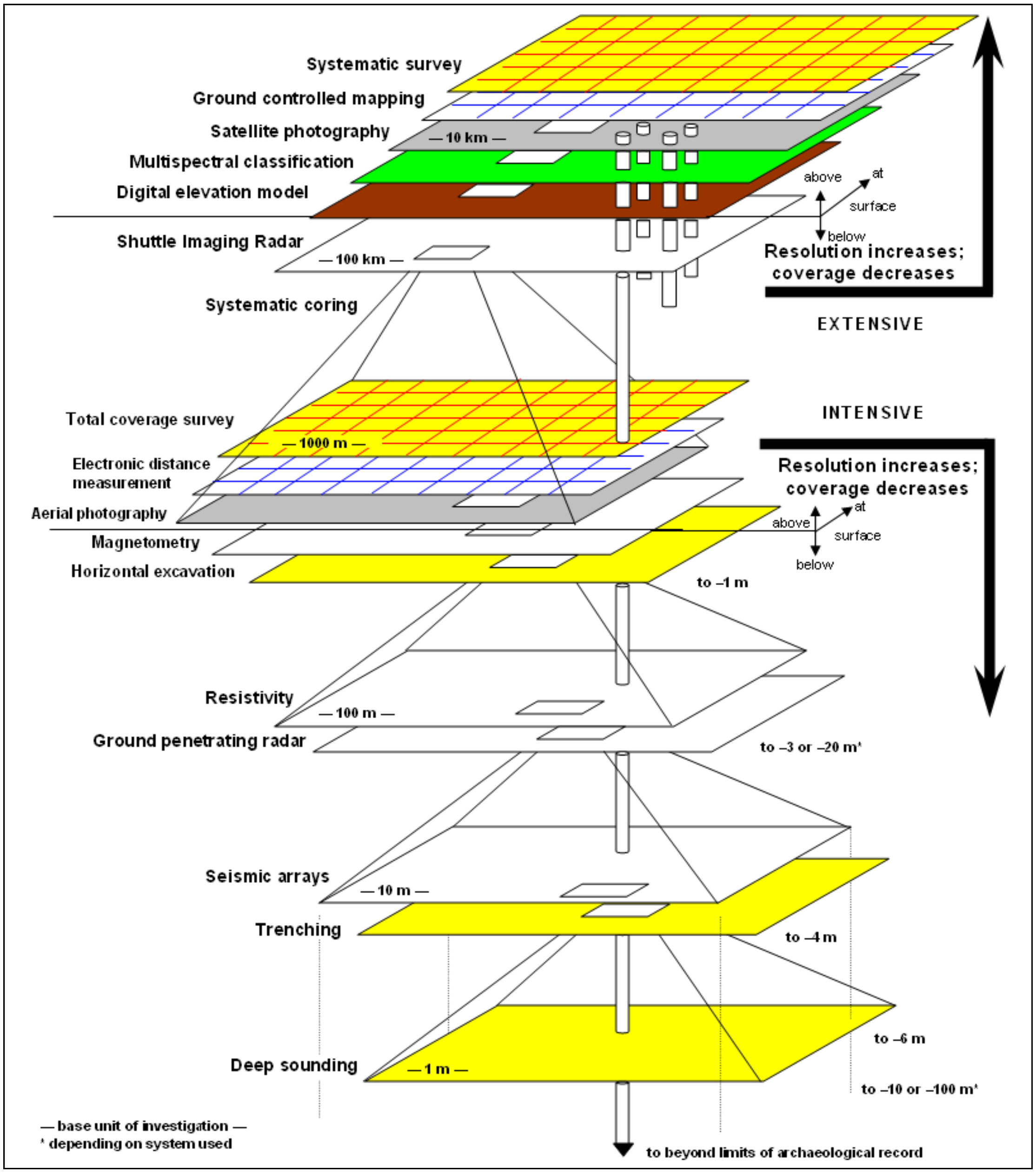

Figure 4: Schematic Relationship Among Remote Sensing, Survey, and Excavation in an Idealized Research Design.

theoretical approaches developed for intensive archaeological study, which applications provide an interpretive framework for intensive local testing. In 1999, for the catchment of a small Early Bronze Age city and its hinterlands, I made a first attempt to use CORONA satellite photographs to accomplish all six of the aims numbered above (pp. 29–30). This exercise included (1) identifying and recording all known (and many previously unknown) individual settlements, suburban zones, roads and tracks, fords, quarries, drainage systems, fields, soils, vegetation cover, and lithic outcrops (2) interpreting the images in light of evidence from previous ground survey, excavation, and Assyriological, paleoenvironmental, ethnoarchaeological, and geomorphological studies; (3) analyzing viewsheds, calculating catchment zones, and estimating trafficability and productivity; and (4) wherever possible, verifying new findings with surface reconnaissance (Pournelle 2001). Methodologically and theoretically informed by emerging concepts of geoarchaeology and landscape archaeology (Miller-Rosen 1986, 1997; Miller and Gleason 1994; Everson and Williams 1998; Ashmore and Knapp 1999; Morris 2000), this exercise in *comprehensive landscape reconstruction* allowed integration of excavation, survey, and remote sensing data of variable resolutions, significantly expanded the known limits of "the site," and allowed us to draw conclusions regarding labor organization and politicized landscape transformations during the life cycle of an archaic city (Algaze and Pournelle 2003).

Comprehensive landscape reconstruction, for the given range of time within which a problem is manifest, attempts to integrate and extend those intensive results with a visible component across a given extensive (regional) space, using photographic analysis to define the likely limits of their applicability and to visualize the resulting integration. To be successful, comprehensive landscape reconstruction requires extensive surface survey, extensive CORONA (or air photo) coverage, intensive local survey and excavation (and preferably pre-excavation air photography) at representative locations, and well-developed ideography. As the project proceeds, a relevant body of ethnographic or ethnohistoric literature is also requisite. An outline for compiling a comprehensive landscape reconstruction is summarized at Table 3.

Table 3: Outline of a Comprehensive Landscape Reconstruction

- Model hydrology
  - trace relict watercourses
  - trace relief
  - plot wetlands
- Model associated local ecology
  - geomorphology
  - paleobotany
  - paleofauna
- Plot built and engineered structures and features
  - settlements
  - field systems
  - waterways
  - roads and tracks
  - walls and fortresses
- Construct associated regional lines of communications
  - utilitarian craft and exotica distributions
  - texts: itineraries, shipping documents
- Deduce semiotic categories[24]
  - mortuary practice, personal adornment
  - architectural, constructed space
  - epigraphy, iconography, ideography
  - poetics, literature
- Compare to ethnographically attested categories

Southern Mesopotamia has proven well-suited to such a project. Added to geomorphologic studies based upon sediment cores (Larsen 1975; Sanlaville 1989, 1996; Plaziat and Sanlaville 1991; Lambeck 1996; Geyer and Sanlaville 1996; Aqrawi

[24] The point of examining such textual, artistic, administrative, etc., sources is not a vain attempt to somehow catalog all that was "known," but to discover what was seen in the context of practice.

1997, 2001), are a recent compendium of known alluviation depths (Reichel 1997) and calibrated radiocarbon dates (Wright and Rupley 2001) correcting and elucidating previous stratigraphic dating inaccuracies (Porada, Hansen, Dunham, and Babcock 1992). While currently closed to field testing, it has been extensively surveyed (Wilkinson 2000a; Table 5) and excavated (Lloyd 1955; al-Haik 1968; Porada et al. 1992) for over a century, with sophisticated integrative studies of both the 'Ubaid (such as Henrickson and Theusen 1989; Schwartz and Falconer 1994) and subsequent Uruk (Adams and Nissen 1972 Adams 1981; Algaze 1993; Kouchoukos 1999; Pollock 1999; Rothman 2001) periods. Well-published iconographic (Amiet 1980; Charvát 1997, 1988; Schmandt-Besserat 1992) and protoliterate Sumerological (Bauer, Englund, and Krebernik 1998; <http://cdli.ucla.edu>) analyses may be added to this list. Regional ethnographies, while limited, are available (Hedgecock and Hedgecock 1927; Field 1936; Maxwell 1957, 1962; Salim 1962, 1969; Westphal-Helbusch and Westphal 1962; Wirth 1962; Thesiger 1957, 1964; Ochsenschlager 1993a and b), and may be compared to ethnographic literature of, for example, riparian cattle-keepers and fishers of the Sudanese floodplain (Evans-Pritchard 1940, Meeker 1989), and ethnohistorical literature of Floridian (Walker and Marquardt 2000), Chadian (Holl 2001) and Malagasy (Dewar and Wright 1993) wetlands. Archaeological findings are also temporally, spatially, and ecologically comparable to those of the Nile delta. Finally, as a center of pristine ancient state formation, regional processes have been theorized in the comparative literature (beginning with Adams' classic study in 1969).

Of remote sensing and photographic data, a wide variety are now available for southern Iraq. A few low altitude, extremely detailed, pre-excavation photographs of major sites are preserved in archives (Table 2). Although Adams and Wright based their original surveys on no-longer-accessible aerial photographs, Pournelle and Adams have assembled comprehensive CORONA coverage, some of which is of excellent quality. Given the radical transformation of the landscape of southern Iraq over the past several decades, these photographs can be quite difficult to relate to current maps and terrain features—a gap bridgeable with georeferenced, medium resolution (10 m), orthorectified SPOT panchromatic digital imagery. Kouchoukos (1998) has used AVHRR and LANDSAT multispectral data to good result for land cover classification.[25] The recent release of Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) imagery makes possible even more detailed analysis and mapping of vegetation, soils, and hydrology.[26] Low- and medium-resolution Digital Elevation Models (DEMs), used to build three-dimensional

[25] Although UC San Diego Calspace labs hold subsurface (SIR-C) radar data, used elsewhere in the Middle East for mapping relict roads and waterways (Clapp 1998), high water tables in the Iraqi alluvium limit its utility there.

[26] The U.S. Government's role in imagery and geospatial data resources on the WWW is so pervasive that it deserves its own directory. The National Imagery Management Authority (NIMA) has declassified and archived global map and imagery holdings; see <http://www.access.gpo.gov/su_docs/fdlp/pubs/proceedings/00pro8.html>. Download SPOT 10m Digital Orthorectified Imagery (DOI) from (no cost) <http://geoengine.nima.mil> or <http://data.geocomm.com/catalog/IZ/group121.html> (fee). Download ASTER from the Earth Observation System (EOS) Gateway at <http://edcimswww.cr.usgs.gov/pub/imswelcome/>; the procedure is at <http://www.terrainmap.com/rm23.html#ASTERPROC>.

visualizations and topological studies, can now be acquired or constructed.[27] While the region is currently closed to American archaeologists, precluding specific test coring, excavation, or ground-based remote sensing, the distinct possibility of access to at least some areas reopening to other European teams within the decade is high. This closure indeed has had some positive benefit, spurring publication, lab work, and ceramic re-seriation for previously excavated materials.

Thus, in answer to the layered requirements of Figure 3, while some things are cost prohibitive, non-existent, or inaccessible, in this case archaeological photographic interpretation may be used to extend the applicable limits of ground data in answering questions of how big, how far, how much, and how often in the context of the Mesopotamian alluvium. There are of course caveats and limits to the applicability of aerial and satellite photography to this (or any) problem. First, photographs record

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[27] The *Digital Terrain Modeling and Mapping Journal* <http://www.terrainmap.com> provides instructions on terrain modeling and mapping using publicly available imagery (SDTS, DRG, DLG, DTED ASTER, Landsat, EarthSat and EarthKam). For program and product descriptions of U.S. Digital Terrain Elevation Data (DTED), see Pike and Aftergood 2000, <http://www.globalsecurity.org/intell/systems/dted.htm>. Low (1000m) resolution DTED 0 is downloadable at <http://geoengine.nima.mil> and discussed at <http://geoengine.nima.mil/geoEngine/help/dted_pub.htm>. Medium (100m) resolution DTED 1 may be requested from: NIA HQ Releases Officer, Attn: ACT, MSA-13, NIMA, 8613 Lee Highway, Fairfax, Virginia, 22031, USA, and is discussed at <http://www.defence.gov.au/digo/digo/ProductsDTED1.htm>. New global DTED 1, prepared by the Jet Propulsion Laboratory from Shuttle Radar Topography Mission, may be requested for valid research purposes, and will be released through the USGS Eros Data Center, as will DTED 2 (10m) over the United States (see <http://srtm.usgs.gov>, <http://www.jpl.nasa.gov/srtm/>, and <http://www.jpl.nasa.gov/srtm/cbanddataproducts.html>. Better (35m) resolution ASTER DEMs, <http://edcdaac.usgs.gov/aster/dem_map_fullimage.html>, are available from the USGS Land Process Distributed Active Archive Center. A procedure for producing DEMs from no-cost ASTER imagery is at <http://spatialnews.geocomm.com/features/childs4/>.

reflected light, not any “actual” terrain feature or archaeological site. Because they do this though chemical emulsions which mimic, but do not replicate, human physiology, they sometimes record objects invisible to, and sometimes omit objects visible to, the naked eye. As discussed above, by capturing frost, moisture, soil, and vegetation marks, they indicate, but do not definitively reveal, subsurface features. While in principle the physical properties underlying surface expression of underlying taphonomy are universally applicable, in practice results gained in Europe must be modified for the arid Middle East in general, and for the silty Mesopotamian alluvium in particular.

Shadow marks are probably the most directly translatable interpretive aid. While obviously not as sensitive to slight surface undulations as very large scale oblique air photographs, fortunately for archaeological investigations, CORONA images were intentionally designed to highlight objects of slight relief. The focal plane tilts fifteen degrees from the vertical, and missions were generally timed for early morning or late afternoon acquisition.

Since little of the archaeologically surveyed area discussed in this study was under cultivation when imaged, crop marks *per se* are of little aid. However, as Kennedy notes, “In Iraq, much help came from vegetation marks, pale toned on banks, dark in ditches” (Kennedy 1998: 554). These are of two kinds. His remark refers to the great sensitivity of xerotropic brush to variations in subsurface moisture at all times. Second, as he further notes referring to Sir Aurel Stein’s surveys, after rains or floods in arid locales the brief blush of vegetation over the alluvial surface offers all the advantages of crop marks better-studied in Europe. Stone (2002) used vegetation marks visualized in SPOT imagery following rare heavy rains at Abu Duwari (Mashkan-shapir) for detailed mapping of Old Babylonian watercourses, discussed in Chapters Three and Four. However, the speciation, duration, and peak occurrence of such phenomena have not been studied with an eye to the best times for image collection as they have for European crops.

Probably more important in the alluvial context is a nuanced understanding of the taphonomy of surface soil moisture variability. For brief periods following floods or rains, the normally uniform, mud-dull deltaic surface appears as variegated as an illuminated manuscript. In this context it is particularly important to use multiple coverage of any given area, from varied seasons, moisture conditions, and times of day. I used at a minimum two sets of CORONA images for each area studied, one taken in May following the spring floods, and another in August, following summer desiccation.

Secondly, photography is limited by the same processes that affect site preservation itself: it cannot record what has not been preserved. Therefore, when extant, the oldest, most detailed air photographs available are *always* preferred as a check on more recent satellite photography.

Third, photographs date nothing. They require traditional methods of ground-truth to associate datable features to what they reveal. However, just as diagnostic potsherds, absent good radiocarbon samples, may be used to date by association other artifacts and features, some anthropogenic landforms and constructions, once sufficiently documented, may be taken as diagnostic—at least of broad periods.[28] Adams's comprehensive study of settlements and their associated waterways remains the foundation study, but in that work he does not typologize features or feature sets on the photographs themselves. The earliest period for which any typological study has been conducted is the Syro-Anatolian Bronze Age. Wilkinson (1990–98) has directly investigated the taphonomy of a distinctive system of radial hollow ways, formed by erosional and depositional processes along ancient routes surrounding and connecting third millennium BCE tells (Ur 2003).[29] As noted above, a great deal of work has been done on aerial identification of Roman remains in the Middle East (Kennedy 2002). While this work is not directly applicable outside the limits of that empire, it does give some sense of the rate of decay of visible surface features, and provides clues to interpreting contemporaneous Parthian remnants in those parts of Mesopotamia just beyond the Roman pale. The sheer massiveness of pre-Islamic Sassanian hydrologic engineering (with canals 50–100 meters wide and hundreds of

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[28] For example, in Britain, "lynchettes" indicating Anglo-Saxon ridge-and-furrow field systems may initially have been ascribed the *wrong* (Neolithic) dates—but they do indeed (now that appropriate dating has been accomplished) uniformly and diagnostically define their own period wherever seen from the air (Hall and Palmer 2000). See Wilson 2000 for a typology of archaeological features in Britain.

[29] The hollow ways at Tell al-Hawa and Tell Bedar are certainly of third millennium BCE origin, as neither has major earlier or later components. The dimensions and pattern of these ways may be characteristic of the same time period in the very different environmental setting of the deltaic south. At Tell Brak, however, there are major fourth and second millennium BCE occupations, and some of the hollow ways seem to articulate with secondary sites of those periods. There is also a pattern of distinctly narrower hollow ways that articulate with Neo-Assyrian and post-Assyrian sites, perhaps related to the use of horses (Wright 2003, personal communication).

kilometers long) makes its major features immediately recognizable.[30]

Finally, air photography introduces a problem of perspective. *No* archaic inhabitant of the flat Mesopotamian delta could have conceptualized his or her environment from the overhead perspective we enjoy. A sense of archaic perspective requires a translation, by software visualization or other means, of our two-dimensional overhead photographic view to a three-dimensional ground-level one. To gain some sense of relief, I consulted stereo pairs wherever available—but for the southern Mesopotamian alluvium, at the level of individual photographs little variation is obvious beyond dominant tells. To help disentangle the various relict terrain features that comprise the palimpsest of that deltaic landscape, I also obtained or constructed digital elevation models (see note 27), overlaid them with draped imagery, and digitally manipulated them to exaggerate relief.

This leads us to several specific problems in using CORONA imagery. First, the rapid disappearance of a cadre familiar with the techniques of optical imagery interpretation and its manual photographic manipulation places artificial limits on the detail theoretically obtainable in CORONA images. EROS will enlarge CORONA negatives only up to sixteen times, although the dense film emulsion of the KH4B series photographs in most cases actually allows for twenty-time enhancement (to under-two-meter resolution). In either case, costs for (paper) coverage of an area the size of the Mesopotamian alluvium would be astronomical. Even 16X enlargement of

[30] This summary composes a short list indeed; I aim in Chapter Four to lengthen it somewhat.

just one CORONA frame would require at least twelve 40-inch-by-40-inch prints; to cover the alluvium in its entirety requires at least thirty frames of imagery.

For this reason, during the pre-digital era, CORONA was interpreted on a light table, using mono- or stereoscopic optical enlargement. This allows the interpreter to view the negative (or a duplicate positive transparency) directly, without attenuation during the printing process or interference from paper grain. However, mapping, illustrating, or annotating results requires further specialized equipment—or conversion of CORONA photographs to a digital form. Digitization protocols and costs are also non-trivial, if the aim is to produce images that actually replicate the quality of the original negatives. There is of course a trade-off between resolution and scanning costs. In order to maximize the former while minimizing the latter, Leta Hunt (USC) and Lynn Schwartz (UCLA) conducted a pilot study that compared a controlled series of CORONA scans using various platforms, technologies, resolutions, and protocols.[31] For most geomorphological interpretation and mapping purposes, 4X paper enlargements and fast, cheap, 600-dpi flatbed scans of 1X contact prints are adequate. These produce images of approximately 1:62,500 scale, which may be optically or digitally enlarged to approximately 1:15,000 scale, that is, approximately 10-meter resolution. For this study, one complete image set (mission 1103) was purchased as a 4X paper enlargement, with an additional 1X partial image set (mission 1104) scanned at 600 dpi.

However, for detailed analysis of archaeological features at air-photo-quality

[31] Including slide, flatbed, drum, cross-field, and specialized air photograph scanners.

(1.6 meter) resolution, best results were obtained using ZI Imaging® aerial photographic scanners, using a proprietary commercial protocol, at 2200 dpi. One complete image set (mission 1107) was scanned by Aerial Mapping Service, Phoenix, AZ, with individual frames from other missions digitized as needed. Two image sets (missions 1110 and 1107) were retained as film positives, and examined optically with a Bausch and Lomb 20X rhomboid Zoom Transfer Scope (Short 1982: 53–54; Teng et al. 1997: 95).

Second, in order to accurately map and measure surface details and associate them to legacy data, such as settlement survey and soil maps, it is necessary to georeference digitized CORONA photographs and reproject them to a common scale and orientation. However, CORONA is neither aerial photography, nor native digital imagery which has encoded within its data stream the necessary geographic values. Algorithms for automated registration and planar reprojection of digitized CORONA do not yet exist for photogrammetric and GIS software.[32] At the same time, in more recent georeferenced, orthorectified, digital imagery (such as Russian KVR 1000 and

[32] ERDAS Imagine™, ESRI ArcView™, or ER Mapper™ all lack such tools. Programmers at these commercial software manufacturing companies, the USGS EROS data center, and the NIMA mapping facility at Ft. Belvoir, VA, as well as GIS specialists at UCSD and the UC Santa Barbara Alexandria Digital Library agree that small areas extracted and enlarged from single frames can be processed as if they were single aerial photographs. However, errors and distortions, especially at the margins of the frame, are high. Solution of this problem requires both camera ephemeris data for the concerned missions and frames, held at the U.S. National Archives, were it must be personally retrieved and photocopied, and custom programming to write algorithms that successfully deal with the "bow-tie" projection that results from true rectification of an entire CORONA strip (Dickinson 1979: 321; Altmaier and Kany 2002: 225–226). While such algorithms do exist for use within specific U.S. government agencies, they have not been declassified or released for use outside those entities.

NIMA SPOT 10m DOI) archaeological features are often undetectable (if small), of poor detail (if large), or obliterated by modern development.

As an interim solution, I modified the "Chicago Protocol," developed at the University of Chicago Oriental Institute Center for the Analysis of Middle Eastern Landscapes (CAMEL), to georeference, register, and mosaic CORONA images (see Table 4). Resulting images were then registered to settlement survey maps (Adams 1981), using major waterways and nearly 1600 identifiable settlement mounds (tells) for ground control. Where I could not be certain of site identification, I also referred to original field notes and sketches, which originally were prepared with the aid of KLM air photographs. Since the original survey maps were drawn by checking positions triangulated in the field against photo mosaics of unknown (and variable) projection, this allowed me to reduce position errors from (in some cases) greater than 1000 meters, to (in most cases) less than 10 meters.

Table 4: Modified Chicago Protocol for CORONA Georeferencing

1. Program/Routine: RSI ENVI™ 3.5/Image Registration
2. Base image: 10m DOI (NIMA SPOT)
3. Warp Image: Digitized CORONA, in 2.25" X 9" blocks (one-third image frame). One inch each from the extreme left and right of the image frame discarded.
4. Ground Control Point Selection: image-to-image, at least three per linear inch; at least one per block corner.
5. Warp method: Second degree polynomial with bicubic convolution.
6. Converted Image format: Geotiff.

Thirdly, while much of the mid-Holocene terrain surrounding early Sumerian cities can be reconstructed with the aid of CORONA imagery, taken in 1968 before modern agricultural operations erased much of the archaic landscape, even by that time decades of excavation at the mounds themselves, compounded by rail- and road-building, had already significantly obscured the relationship between their made-made (construction; irrigation) components and "natural" geomorphologic settings. Massive amounts of excavation and construction spoil now hide significant hydrologic and contour features clearly visible in the very few published aerial photographs (such as Hall 1930) taken during and immediately following WWI.

Before discussing the most stringent caveat on photographic interpretation, I must first distinguish between *terrain* and *landscape*. By *terrain*, I mean a geographical area; a piece of land, and the geophysical features of that tract of land. I take as axiomatic that terrain is a totality of what physically *exists*, and that knowing what it is (or was) is the province of physics, geology, and geomorphology (Miller-Rosen 1986; Miller and Gleason 1994; Wilkinson 1997).

By *landscape* I mean those physical features and qualities visible, detectable, or expressed at ground surface, within which social activity takes place. It is *landscape* that is perceived, manipulated, assigned relevance, acted upon by, and incorporated into social technologies and systems. Landscape carries with it the several senses expressed in the English definition of that word, "a particular area of activity"; "a portion of territory that can be viewed from one time and one place"; "a picture representing a view of natural inland scenery" (Webster's Unabridged Collegiate, 10th ed.: 654); and may be coterminous with, but is generally a subset of, terrain.

Landscape thus implies a socially relevant boundedness in space, time, utility, and perception.[33] Whether or not terrain characteristics are acted upon (or even perceived), they will be relevant to the creation and articulation of social institutions, for they will enable some, preclude others, and positively or negatively sanction many more. This relevance however, has no necessary connection with any particular meaning, practice, or imagined quality.[34] A terrain of physical mountains comes to be a sacred, scenic, or challenging bastion because some of its physical qualities are socially relevant. Insofar as they enter the realm of social contemplation, decision, practice, and consequence, those qualities become elements of landscape.

This makes for a slippery boundary between "terrain" and "landscape." A rock in a stone field is merely a rock, and as such is merely a bit of terrain—until a

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[33] Imagine for a moment broken, rugged, basaltic mountains. That they are broken, basaltic, and higher than sea level is an identifiable, quantifiable aspect of terrain. That, for all plant life there, the season of active growth is short; patches of fertile ground few and subject to glaciations or sudden erosion; that cataracts of water condensed from scattered clouds cascade through deeply incised channels; that movement across horizontal distances requires tremendous effort and thousands of cumulative feet of vertical climb and drop; that successive ranges block daylight; that from particular vantage points within them vast tracts of lower lands are visible (and other tracts are not)—these and other features are socially relevant in that they bound the range of social possibilities for how to live and what to do. Agriculture is barely possible without terraces to hold soil. Cultivating tomatoes is impossible without inventing hothouses. Travel by wheeled cart is impracticable without engineered roads, and travel upriver by water out of the question (unless you are a salmon). On the other hand, you *can* deep freeze your dead (if you can carry enough food for the climb); summer pasture your livestock (if you can spare the labor to herd them); and dig metal ores extruded at the surface (if you care about metal ores).

[34] Perhaps mountains are therefore places to be avoided. Perhaps to be revered. Perhaps they are challenges to be tackled and engineered. Perhaps they are frightening, empowering, enervating, tranquil, sacral, or profane. A monk views them as stairways to God. A tourist views them as scenery. A general views them as defensive bastions. A road planner views them as an engineering challenge (or nightmare).

particular weight and heft and color and texture and friability mark it as the rock of choice for ground stone manufacture, at which point a terrain feature—“vesicular basalt field”—becomes the real horse of “ore source for ground stone production” in a Neolithic landscape. Without a millimeter of movement, the rock crosses from merely being, to being seeable (and thence seen).

In their juxtaposition, the epigraphs with which I opened this chapter therefore reflect not merely alternative, but a range of concepts conflated in current literature under the rubric “landscape archaeology.” In his introduction to the fourth International Assyriological Symposium (Venice, 1997), Jean-Louis Huot addressed a distinguished panel invited to consider the theme: “Landscapes: Territories, Frontiers, and Horizons in the Ancient Near East.” Huot masterfully summarized the state of “landscape” studies in Mesopotamia, distinguishing the archaeology of “physical” from the archaeology of “mental” landscape. In the former category, he included investigation of paleogeological, paleoenvironmental, paleozoological, and paleobotanical remains, and their association to human settlements as revealed by site surveys and paleogeographical studies.[35] In the latter category, he included investigation of cosmological representations and maps; senses of “borders” and “frontiers” revealed by border demarcation devices such as stelae, stones, epigraphs,

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[35] His synthetic commentary summarizes the state of such investigations in the southern alluvium, concluding that maximum sea level “was reached around the end of the ‘Ubaid period in the fourth millennium BCE. The first inhabitants of southern Mesopotamia made good use of their environment: hunting, fishing, irrigated crops and raising of pigs and cattle which are well-adapted to marshes were among their normal activities. Clearly, at the end of the prehistoric period lower Mesopotamia was not at all a hostile environment.” (Huot 1999: 30).

altars, and stands; "landmarks" and "monuments" demarcating roads, including rock-carvings; and esthetic perceptions of landscape revealed in representative art.

Huot thus divided landscape studies between the province of science—in which "interdisciplinary" research "couples archaeological investigations with scientific research on man and environment" (1999: 29)—and humanities, in which epigraphers and art historians attempt to discover "how the people of the ancient Near East and Middle East perceive the world around them" (1999: 33). He did not in that essay address the emergent body of archaeological literature (from other regions) that seeks to transcend that boundary, reforming constellations of interdisciplinary research that, on the one hand, use geomorphologic and related methods to tackle mental questions regarding patterns of human land use and perception of land over time,[36] and on the other, draw upon historical, geographical, architectural, and social theory to interpret physical data such as pollen sequences, pedology, geomorphology, or scale and spatial distributions of explicitly anthropogenic features.[37]

This trend toward conflating a broad range of activities under the rubric "landscape" is of course largely a result of the polysemous usage of that term in the English (and other European) languages. It is also a result of the conflation under that term of a number of practices dealing directly with soil, as opposed to *objets d'art* or architecture per se. Archaeologists study anthropogenic material remains—the results

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[36] Including the newer "environmental" archaeologies of Miller-Rosen; Stein; Wattenmaker; Miller and Gleason 1994; see also Holl 1998.

[37] See, for example, the special section of *Antiquity* 73 (1999: 630–688); Ashmore and Knapp 1999; Smith 1999.

of repetitive human action.[38] The multidisciplinary approach so successfully pioneered in the Zagros by the Braidwoods (1983) demanded attention to the conception of culture expressed by in Huot's epigraph. The sphere of material remains has become ever-more inclusive of geomorphological, paleoenvironmental, and taphonomic data such as those masterfully assembled by Sanlaville, Huot, Wilkinson, Miller-Rosen, and others further discussed in Chapter Three. With the growing trend toward investigation away from palace/temple precincts, archaeologists attempted to interpret these material remains not solely as statements of localized environmental adaptation, but in terms of broader processes.

Unsurprisingly, the first of such systems considered were systems of material (exchange) relations, expressed as the spatial distribution of material remains across a broader landscape, and their relation to the theorized collective action (for example, economic and political organization) of access, control, exchange, technology, and management. Early on, such efforts at times led to erroneous functional conclusions (such as Wittfogel), but over time they laid a groundwork and created a demand for further investigation of social relations. Clearly, even on cursory reflection, accumulated material remains are more than the detritus of material relations. Over the

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[38] The occasional good fortune—from an archaeologists viewpoint—of a burnt, collapsed, or tephra-enshrouded city notwithstanding. However, with the possible exception of Pompeii, even in such cases the rigors of subsequent bioturbation and site taphonomy render the preservation of a one-time, once-repeated, rare, or unique occurrence unlikely. As Pompeii itself shows, (recognizable) human activity repeats across space within a city, as well as through time within those spaces. It was the commonality of keeping dogs and baking bread that made it likely that, on a given day, a volcanic eruption would preserve pets and loaves.

long term, they are also evidence of other social interactions.

In certain cases, what structures these interactions is terrain, in the sense of the physical, surface locale. In others, terrain is structured by human perception, cognition, and action to create (what Huot would call "mental") landscapes. But as Smith points out in the opening epigraph, landscapes, apart from the terrain on which they rest—as the cognitive ordering of the terrain perceived—structure human relations. Collective social action thus both inscribes, and is inscribed by landscape. Landscape is a repository of memory, and therefore is reworked through time (Schama 1995). Smith's consideration of the role of landscape in political legitimation marks an archaeological transition from the (material) political economic to the (materialized and materializing) cognitive. Other landscape memories—such as place-naming—encode and inscribe (for example) ethical and moral systems (Basso 1996).

The power of unwritten presumptions about terrain and landscape is revealed in the past two centuries of European (and archaeological) discourse about what gave birth to ancient (Mesopotamian) civilization. The practices of that past discourse led to a consistent misinterpretation of evidence that we might now see as obviously pointing away from "Foundations in the Dust," to abuse the title of Seton Lloyd's fine summary of pre-twentieth-century investigations of the alluvial past (Lloyd 1955), and toward the "Foundations in the Muck" proposed herein. That system included: (1) training in Enlightenment, Victorian, and Modern ideas about health, technology and management; (2) imposing on the past observations of, and direct interaction with, the terrain of the day; (3) limited interaction between Assyriologists and archaeologists, compounded by (4) teleological imposition of facts and models extracted from historical texts on millennia-older pre- and proto-literate societies.

One might counter that these tendencies have long since been outweighed by a roster of newer techniques, now (fairly routine) practice, introduced over the past several decades precisely to examine ancient terrain in ways that might challenge prevailing landscape views. Despite data from screening, flotation, palynology, coring, remote sensing, satellite photography, and photogrammetry, the prevailing desert-defined landscape model persists into the new millennium, reinforced by noisy debates—even among hard advocates of the science side of Huot's divide—that consistently focus on the social impact of the dry, the drying, the drought, the change for the desertifying worse (notably, Weiss and Bradley 2001). These implicitly stress the importance of irrigation and agronomic technology, and mountains of accumulated data have posed scant challenge to the sense of landscape engendered among many Mesopotamianists by the discourse of the past century.

The converse of Walter Benjamin's aphorism—"Every image of the past that is not recognized by the present as one of its concerns threatens to disappear irretrievably" (Benjamin 1986 [1940])—is that concerns of the present recognize and thus preserve specific images of the past. The persistence of Enlightenment ideas into the Modern traverse of Iraq's central deserts; the splitting of disciplinary boundaries between philology and archaeology; the anachronous concern with agricultural practices in prehistoric societies; the drive to map—comprehensively, synchronically, and diachronically—mounds, monuments, roads, fortresses, canals, fields, settlements, soils, and geomorphology, *all* derive from an aim to describe human action in Modern landscape (not terrain) terms. Geologic survey using satellite imagery is the handmaiden of mining; topographic analysis, of transportation and telecommunications route planning; land cover classification, of forestry, agronomy, and the like. Analysis of constructed features—by urban planners; in engineering studies; by military targeteers—is self-evidently such a defining process; a piling on of socially constructed landscape features.

So, the final caveat I must place on the role of CORONA in archaeological studies is this: photographic interpretation does not precisely reveal a past terrain: it instead fits within a nested set of protocols for constructing a landscape, using terms and descriptors of Modern landscape. What I do here is of course (yet again) a landscape construction—one that I hope evades functionalist tautologies; that is informed, and not merely re-encoded, by data revealed with the above techniques, and that may be explicitly tested (at least in its material dimensions) in years to come. Whether it is possible, however, to altogether escape the intellectual legacy outlined above is another matter, and a topic to which I will return in Chapter Five.

III. VISUALIZING DELTAIC GEOLOGY

Aqueducts divert half the river's flow hundreds of kilometers across rocky scrub to transform suburban basins into palm-bedecked gardens. Along the way, irrigation supplants the ungenerous and unpredictable supply from intermittent streams, watering almonds and pistachios; apricots and pomegranates; dates and figs. Further southeast, another third or so of the river's output turns pockets carved into the desert an improbably brilliant green. Water diverted through the tails of grandiose canals dumps spent, briny water into manmade lakes rimmed with salt grass, stocked with fish, and flocking with waterfowl. Still not exhausted, the mighty river has more work to do before sinking into the sands at the head of its warm marine Gulf. At its most southeastern reach, diverted and spread through a grid work of reed-lined irrigation ditches, it carpets its own alluvium with another checkerboard of market-garden crops. Beyond these fields, under a pall of hanging dust, is a seemingly featureless landscape of grey powder and white salt pannes—relics of what were, until even a few decades ago, vast wetlands covered with reed brakes and teeming with wildlife.

The river I describe above is neither the Tigris or Euphrates—although the description, nearly verbatim, could apply to either—but, as I indicated in the preface to this volume, the American Colorado. So indistinguishable is the desiccated lower Colorado basin from the summer dustbowl westward of the Shatt al-Arab, that American tank commanders trained there in preparation for their assault on Nasiriya.

Durining the past century, in years of low discharge, the combined low season (August–October) Tigris and Euphrates outflows have been approximately double that

Table 5: Tigris and Euphrates Peak flows, as compared to American rivers.

cfs	cumecs	River	Season	Year(s)	Measured at
		LOW SEASON			
50	1	Boulder Creek[1]	Fall/Winter		
1,000	29	Boulder Creek	May/June		
2,825	80	Euphrates[2]	August min	1931–66	Hit
5,000	143	Colorado[3]	normal		above Lake Powell
7,415	210	Tigris[4]	October min	1931–66	Fatha
12,000	343	Colorado	peak discharge		from Glen Canyon Dam
18,714	540	Euphrates	August max	1931–66	Hit
31,426	890	Tigris	October max	1931–66	Fatha
		HIGH SEASON			
42,372	1,200	Euphrates	May min	1931–66	Hit
60,027	1,700	Tigris	April min	1931–66	Fatha
100,000	2,857	Colorado	flood peak		above Lake Powell
160,166	4,536	Red River[5]	flood peak	1997	below Assinibone
163,132	4,620	Red River	flood peak	1852	below Assinibone
194,205	5,500	Euphrates	May max	1931–66	Hit
222,453	6,300	Red River	flood peak	1826	below Assinibone
247,170	7,000	Tigris	April max	1931–66	Fatha
564,960	16,000	Tigris	flood peak	1954	below Baghdad-Diyala
3,000,000	85,714	Mississippi	flood peak	1993	

Source: USGS 2002; FAO 1997. 1. Colorado, joining the South Platt at Denver; 2. Turkey–Syria–Iraq (joining the Tigris at Qurna to form the Shatt al-Arab, emptying into the Persian Gulf); 3. Colorado–Utah–Nevada-California/Arizona–Mexico (Sea of Cortez); 4. Turkey–Iraq 5. Texas/Oklahoma-Arkansas–Louisiana joining the Mississippi above Baton Roge at Assiniboine. See Figure 4.

of normal discharge of the Colorado River above Lake Powell (Euphrates discharge being about one-third less, and Tigris discharge about one-third more, than that river's) (Table 5). On the other hand, maximum Tigris-Euphrates low season discharges exceed high season Colorado river discharges (from the Glen Canyon dam) by about five-fold, and the combined *minimum* joint Tigris–Euphrates discharge during their April–May high season equals that of the Colorado's highest recorded flood peak above Lake Powell. Maximum high season (April–May) outflow of *either* the Tigris or the Euphrates normally equal or exceed Red River flood peaks below

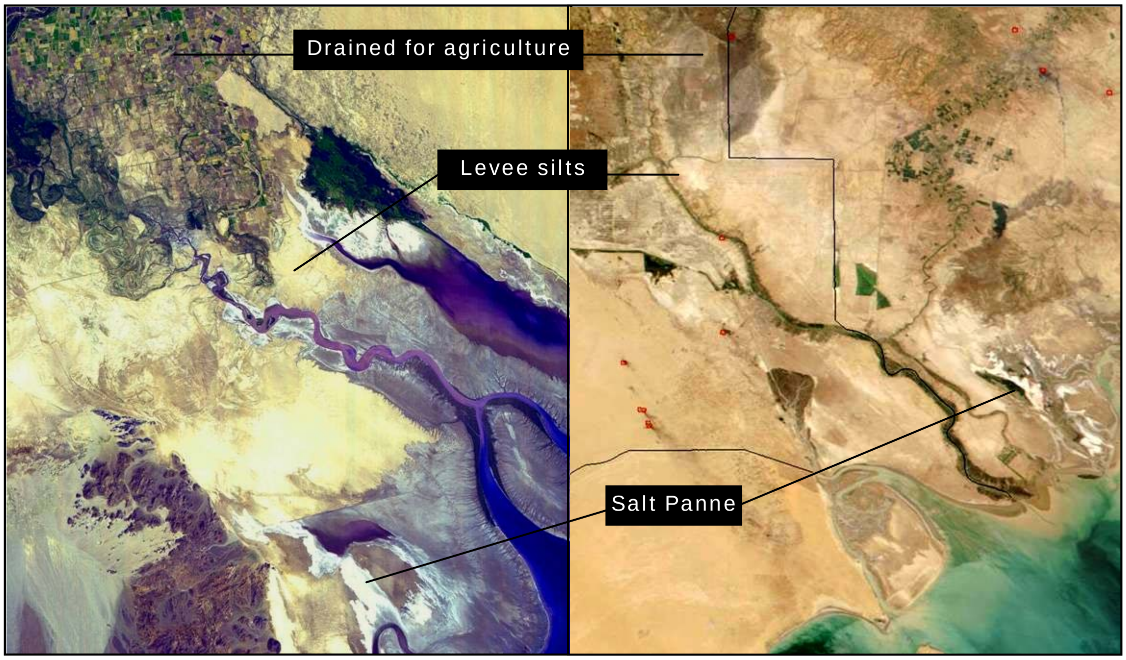

Figure 5: A Tale of Two Rivers: the Colorado (L, USGS 1999 false-color ASTER) and Shatt al Arab (R, NASA 2001b true-color MODIS) Deltas. Upstream dams have accelerated downstream channel aggradation (Goudie 1990: 160).

Assinibone, but the Tigris 1954 peak at Baghdad, below its confluence with the Diyala, dwarfed even the Red's 1826 record by three-fold. Thus, in terms of flow volume the Colorado and the Red are (roughly) the most comparable American rivers to the Tigris and Euphrates. However, although in its upper reaches the Red flows through arid badlands along the Texas-Oklahoma border, it drains through ever more humid terrain, finally crossing Louisiana to join the Mississippi above Baton Rouge. The Colorado remains most similar in terms of the terrain it transits, especially in its lower reaches, where it meets the Sea of Cortez (Figure 4), and therefore serves as a model for imagery interpretation of the Shatt al-Arab delta (Coleman, Roberts, and

Huh 1986). [39]

The Mesopotamian alluvium as a whole is so flat that over broad areas even small changes in precipitation and sea level markedly affect the degree and extent of inundation, as well as local ground water levels and soil and water salinity. Those considerations are clearly critical to the location of specific communities, and become more so the further southeastward one proceeds. But conclusions regarding habitability of the southern alluvium have been driven largely by the imbedded notion that the earliest large, permanent settlements were the result of colonization under conditions newly, uniquely, or primarily favorable to agro-pastoral production—a position which is increasingly untenable (Potts 1997: 47–55). Joan Oates' early views regarding the attractions of a rich hunting and fishing potential in southernmost Mesopotamia (Oates 1960: 48) would seem over recent decades to have been born out in a number of Middle Eastern locales, where even well outside the alluvium, close association of large, sedentary sites to wetlands has been noted.[40] Paleobotanical evidence suggests that, in general, the early-mid Holocene (seventh to fourth millennia BCE) was considerably wetter than at present, and that especially during the late fifth millennium the alluvium may even have experienced summer rains (el-Moslimany 1994; Hole 1998b; Miller 1998; Zarins 1990: 49–50).

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[39] Even the Tigris's 1954 rampage pales by comparison to the power of the Mississippi.

[40] See: Jericho (Bar-Yosef 1986); Umm Dabghiyah (Oates and Oates 1977: 116–117); Çatal Höyük (Agcabay et al. 2001); lower Khabur (Hole 1998a: 45); Choga Mami (Oates 1972: 124–127 plate 23; Helbaek 1972: 39).

Four factors are important in assessing the extent and character of surface water and vegetation in the archaic silt lands between the rivers (see Map, Figure 90). The first is the timing, rate, and volume of Tigris and Euphrates water discharge, determined primarily by the quantity and seasonality of precipitation (and melting of the snow pack) at their respective Zagros/Taurus headwaters. These are in turn affected by climatic oscillation of the Mediterranean storm track at annual, decadal, and centennial scales (Mann and Bradley 1998). Second is the amount, extent, and seasonality of rainfall on and around the alluvium, primarily affected by displacements of the summer Indian Monsoon (el-Moslimany 1994). The third is the location of major Tigris and Euphrates distributaries, and the associated wetlands of their inner deltas. The fourth is the extent of saline penetration and related tidal flushing, determined by the location and timing of marine transgressions and regressions at the head of the Persian (Arabian) Gulf—processes influenced by tectonic uplift, sediment compaction rates, and global sea level variation. While taking into account recent paleoclimatological and sedimentological work regarding the first two factors, in this chapter I introduce new evidence, derived from satellite imagery interpretation, regarding the third and fourth.

Before examining anthropogenic influence on the evolution of the Tigris–Euphrates basin, we require a clear understanding of the major controls on sediment deposition and deflation in its deltaic system. These include tectonic, climatic, fluvial, and eustatic processes. In the following discussion, I do not seek to recapitulate the history of various models for these. Rather, I focus on recent data that updates or expands specialist analyses, including ground and imagery studies.

A. Tectonics: The Mesopotamian Zone

Fundamentally, drainage through lower Mesopotamia is controlled by a great downward flexure (geosyncline), formed by slippage of the Mesopotamian Block of the Arabian plate beneath the upward–thrusting Iranian Zagros Mountains (Figure 5). This slippage forms an unstable shelf area (the Mesopotamian Zone) upon which Quaternary alluvial sediments are deposited (Buday and Jassim 1987). To the west, along the edge of the stable shelf area, the Mesopotamian Zone is bounded by the limestone uplands of the Salmon zone—a broad tectonic unit that extends far into the Arabian shield, is conspicuous in its north–south trend, and dips nearly uniformly in

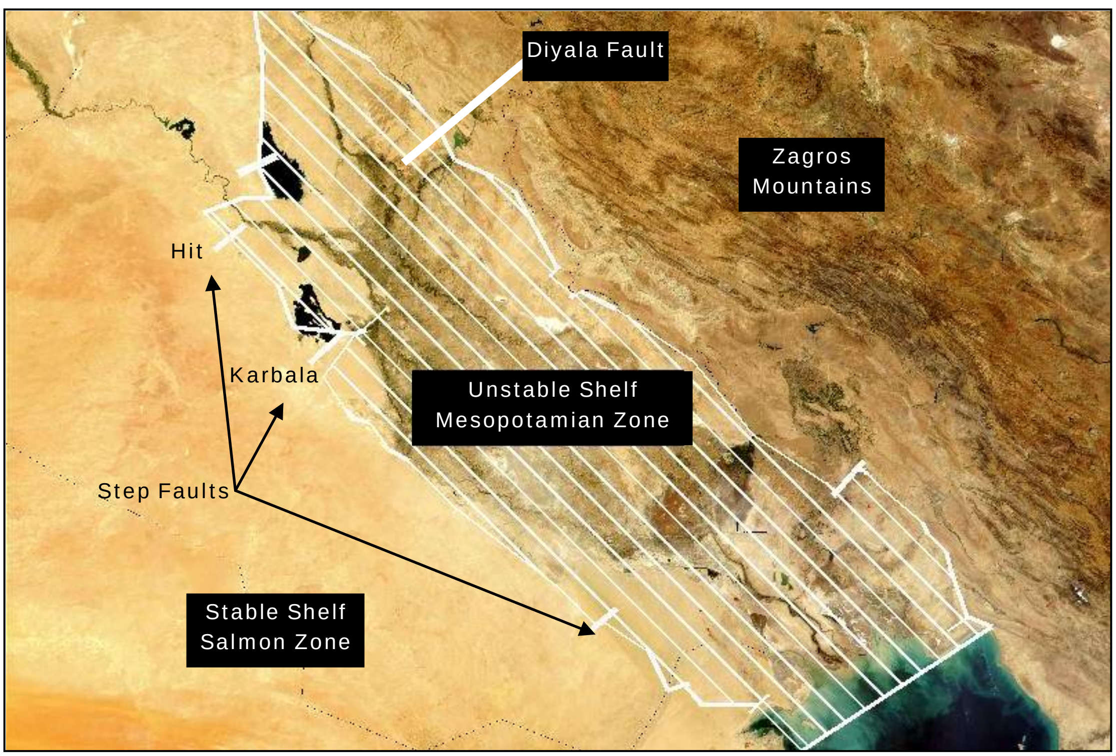

Figure 6: The Mesopotamian Zone geosyncline (white hachure) forms where the Arabian plate is forced below the Zagros Mountains. Image: NASA 2001b MODIS.

the northeastern direction (where it borders the unstable shelf). The transition from the stable to the unstable shelves is demarcated by an abrupt drop in elevation of ten–twenty meters, punctuated by relatively small step faults, most easily visible on the surface at Hit (Buday and Jassim 1987).

Three subunits can be distinguished (Figure 6). The Tigris Sub-zone (Baghdad depression) is the most extensive, and the deepest syncline. From Samarra to Baghdad, where it drops abruptly at the Diyala fault, it trends northwest–southeast, punctuated by narrow northwest-trending upthrusts (anticlines). Between Najaf and Kut, gravity gradients and basement orientation indicate that the zone is west–east trending along an oblique fault zone. At Kut, the boundary of the sub-zone turns

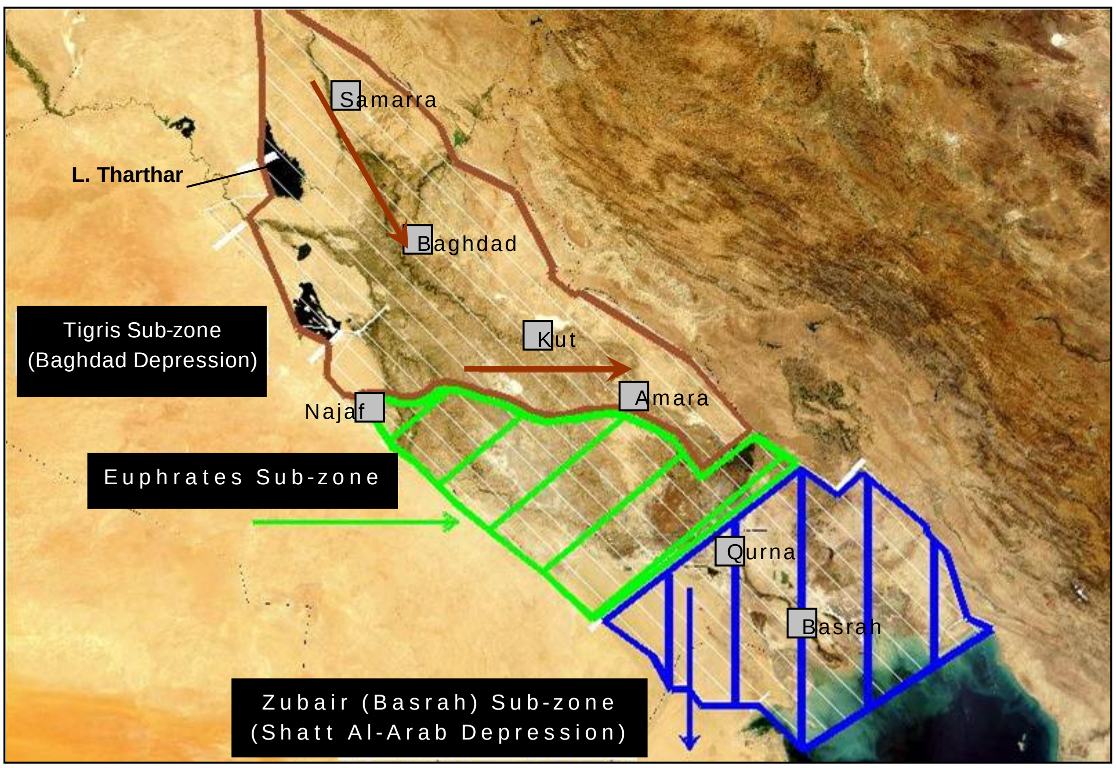

Figure 7: Mesopotamian Zone tectonic subunits. Arrows, hachure indicate tilt direction. L. Tharthar indicated for reference in comparison to Figure 7.

southeast to follow the course of the Samarra–Amara divide to the Takhadid–Qurna Deep Fault. The Euphrates Sub-zone comprises a monocline dipping to the northeast, with scattered local structures. To the southeast, the Takhadid–Qurna Deep Fault separates it from the Zubair Sub-zone (Basrah Zone; Shatt al-Arab Depression), which straddles the boundary between the Mesopotamian and Basrah Blocks. Its uniform, north–south trend empties into the Shatt al-Arab estuary and continues southwards for hundreds of kilometers (Buday and Jassim 1987).

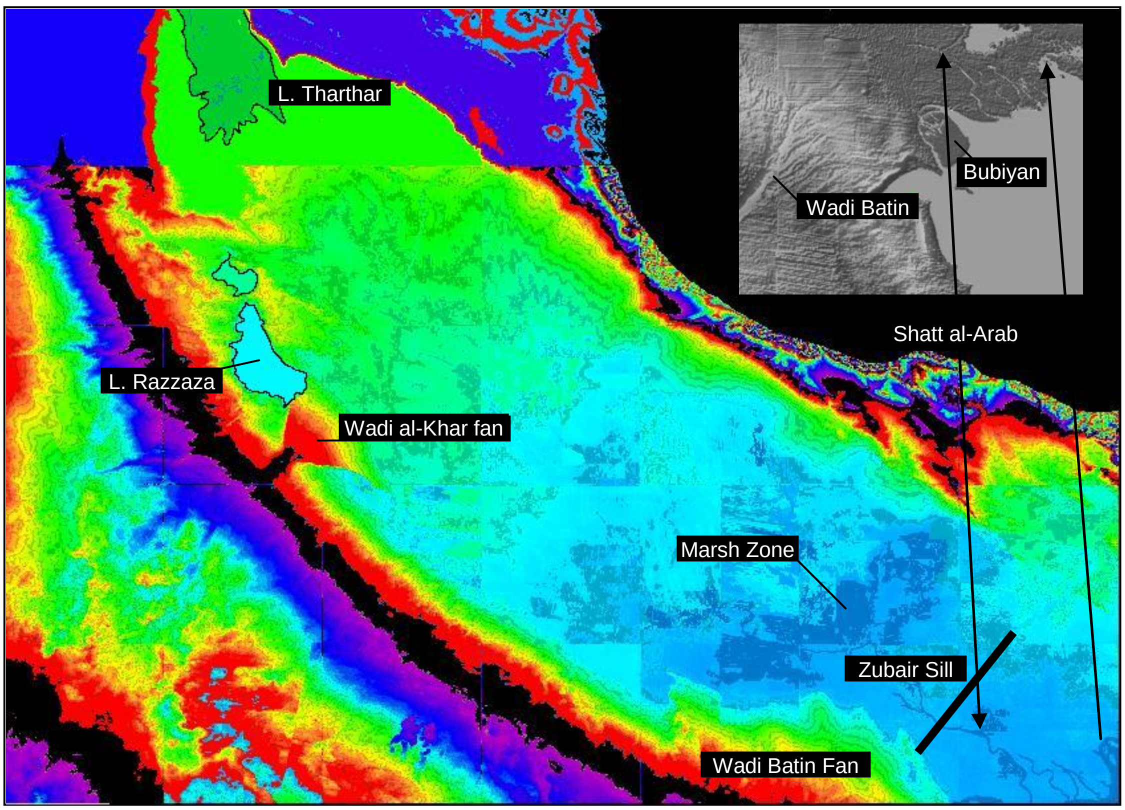

Figure 8: Mesopotamian alluvial topology, showing sharp drop to the unstable shelf, and southeast trend tilted toward the Zagros from Lake Tharthar to the Gulf. The Wadi al-Khar's alluvial fan tends to push Euphrates water eastward. Fresh water ponds behind, and tidal flushing extends inland to, the Zubair sill (black bar). Inset: southeast of the Zubair sill, including the Wadi Batin alluvial fan, Bubiyan Island, and Gulf head. Manually retouched mosaic of NIMA DTED0 1° quadrangles, with ENVI™ 3.5 color table (Purple-Red+Stripes), linear stretch (16:243) applied.

The block, zone, and sub-zone boundaries are significant in their deep structural effects on hydrologic trends and sediment deposition (Figure 7). While the entire zone tips from the northwest (at Samarra) to the southeast (at Basrah), its plane is also twisted northeast towards the Zagros as it is subducted below the great mass of those mountains. Thus, waters of the Tigris, down cutting as they drop onto the alluvium at Samarra, tend to flow south-southeast following the trend of the Tigris sub- zone, while seeking always the lowest ground along the base of the Zagros piedmont. Waters of the Euphrates, dropping downward from Hit, tend to follow the eastward warp of the Euphrates sub-zone, until at some point they join those of the Tigris to join the Shatt al-Arab. The combined outflows, passing southward through the Zubair sub-zone, are slowed by the block boundary at the Zubair sill, behind which fresh water tends to pond, and to which tidal action extends.

Along the western shelf border, Quaternary sediments have eroded away, exposing patches of Miocene plateau limestone. During dryer periods and seasons, windborne sand pours down from the Arabian shield, forming dune fields which are then carried southwestward ahead of prevailing winds (Figure 8) (Al-Dabi et al. 1997). During wetter periods and seasons, slip faults tend to funnel intermittent streams falling from the plateau to the alluvium, creating sediment fans below their nick points, as is clearly visible in Figure 7 for the Wadi al-Khar. The most dramatic of these fans is that of the Plio-Pleistocene Wadi Batin fluvial cone. In aggregate, these intrusions and sediments constrain southerly flow of water, reinforcing the Euphrates' easterly trend in its search for an outlet to the Gulf.

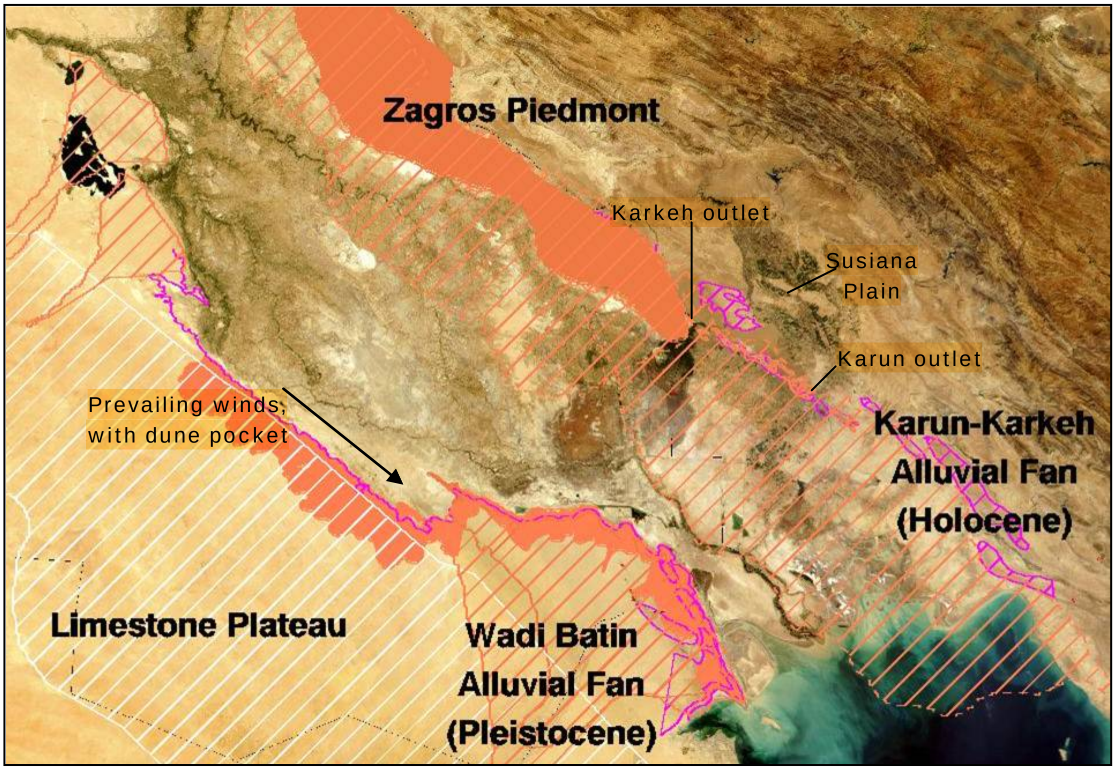

Figure 9: Boundary uplands

Against these constraints are set those of the Mesopotamian Zone's (north)eastern boundary, sharply demarcated by the folded uplands of the Zagros piedmont. These gradually decrease in elevation trending southeast, emerging through Susiana sediments as a series of northwest–southeast low ridges, the most southerly of which (Ahwaz) is bisected by the Karun River (Spaargaven 1987). Piedmont sediments, carried downstream during pluvial periods, have deeply buried the zone boundary in a series of merged alluvial fans that tend to push Tigris waters southward from its southeast-trending flow. Thus, as the Shatt al-Arab crests the Zubair sill enroute to the Gulf, it passes through a sediment-framed bottleneck, where the uniform trend of the Zubair sub-zone allows for much mixing, scouring, and releveling of sediment during river floods and marine incursions.

B. Climate

Two regional climate systems contribute to inter-annual variability in, seasonality of, and amount of precipitation influencing sub-regional microclimate, soil moisture, wetland formation, and the availability of irrigation water across the alluvium. As stated above, the timing, rate, and volume of Tigris and Euphrates water discharge through its deltaic funnel is determined primarily by the quantity and seasonality of precipitation at their respective Zagros/Taurus headwaters. This is in turn affected by climatic oscillation of the Mediterranean storm track, under the influence of the North Atlantic Oscillation (NAO) (Cullen and deMenocal 2000). As of the mid-twentieth century, late autumn and winter westerlies, steered by the subtropical jet stream, drop precipitation on the Levantine uplands and Taurus piedmont, eventually penetrating far inland to build the Taurus and northern Zagros snow packs (Mann and Bradley 1998). In wetter years, this results in minor contributions to Euphrates mid-stream tributaries as early as late September, and to the upper Tigris as early as late October, resulting in slight flow increases beginning in October and November, respectively. Discharge volume builds slowly throughout the winter, until beginning in late February (Tigris) and March (Euphrates) the spring thaw quickly doubles flow, peaking respectively in April and May. Thereafter, deprived of upstream water, the rivers' volumes drop rapidly, until by early September their joint discharge is less than one-tenth of that at flood peak (Table 6; Figure 9; Figure 10).

Northwest–southeast displacements of the summer Indian Monsoon affect the

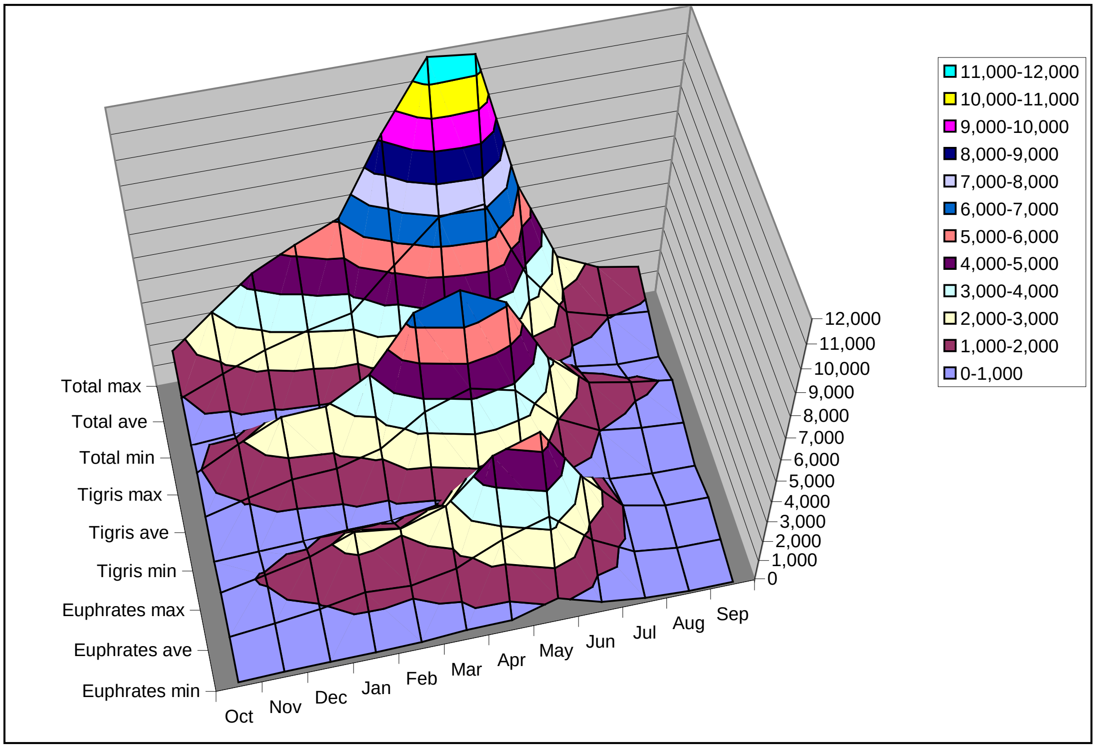

Figure 10: Tigris and Euphrates mean monthly discharge (cumecs) 1931–66.

amount, extent, and seasonality of rainfall on, east of, and southwest of the lower alluvium. When pressure variations over the Asian land mass deflect monsoonal rains westward from the Indian Ocean, spring and summer rains and mists increase, during storm surges (el-Moslimany 1994). In this case, wadi runoff and early spring rains make a morass of much of the Ur-Eridu depression from March to May (Hall 1930). The bi-seasonal monsoonal cycle can also result in autumnal storms that lash across the deltaic wetlands and lower Zagros foothills beginning in October (Thesiger 1964), and contribute to the slight winter rise in river flow. While not (now) raising total annual precipitation above the 200 mm minimum threshold associated with rain-fed grain cropping, these rains open and conclude the annual cycle of seasonal pasture growth, contribute to retained soil moisture, and retard depletion of water levels in the lower delta. Along the alluvial margins, the combined outflows of upland runoff (Figure 11), as well as percolated groundwater and irrigation drains, tend to create seasonal wetlands ranging from high soil moisture to reed swamps (Figure 12). The intermittent stream flows triggered by these storms are also a major source of sediment along the alluvial margins. These and fluvatile sediments form depositional lobes between dune channels and behind dune dams deposited along the alluvial–plateau margin (Wells 2001). During floods, active channels scour and re-scour, mixing sedimentary layers. The complicated stratigraphy of such structures may be more clearly revealed in overview than by small-scale excavation (Figure 13).

Despite rather sweeping claims made for paleoclimatic reconstruction and

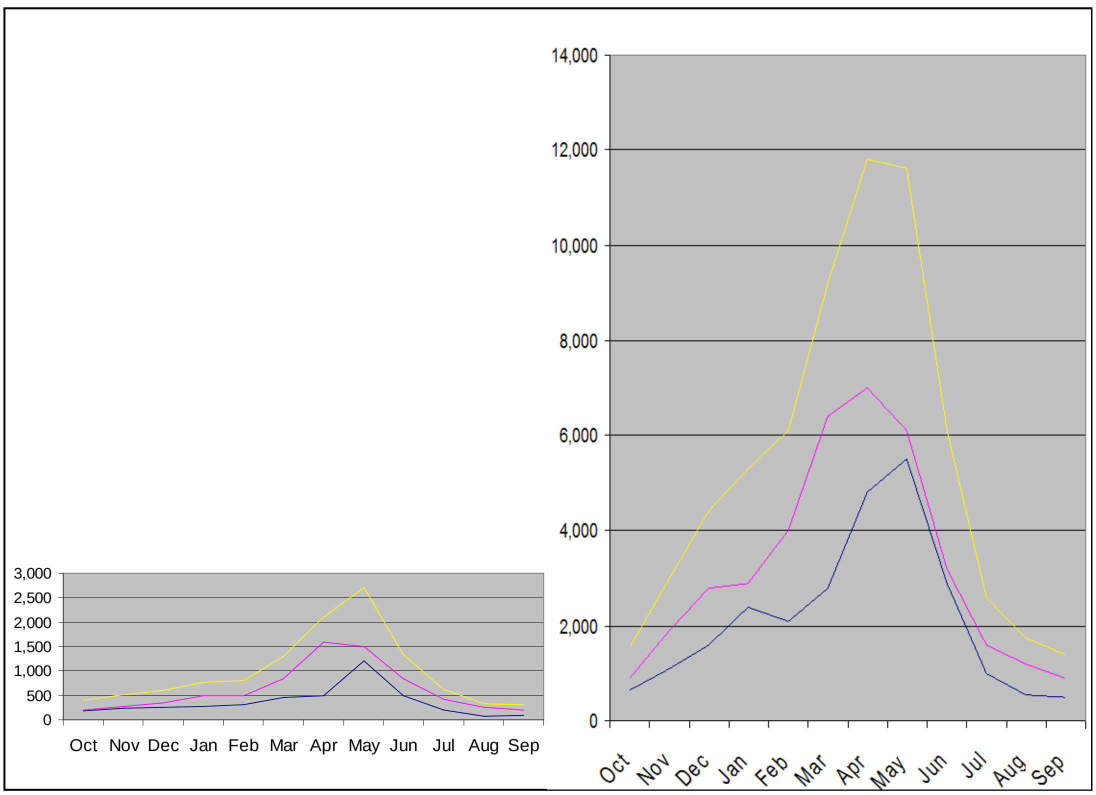

Figure 11: Euphrates vs. Tigris minimum, mean, and maximum discharge, 1931–66.

Table 6: Tigris and Euphrates mean monthly discharge (cumecs), 1931–66*

		OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Euphrates	**min**	190	240	260	280	310	460	500	1,200	490	200	80	100
Euphrates	**ave**	420	670	930	1340	1205	1630	2650	3350	1695	600	310	295
Euphrates	**max**	650	1,100	1,600	2,400	2,100	2,800	4,800	5,500	2,900	1,000	540	490
Tigris	**min**	210	280	350	490	500	840	1,600	1,500	850	420	250	210
Tigris	**ave**	550	1090	1575	1695	2250	3620	4300	3800	2025	1010	725	555
Tigris	**max**	890	1,900	2,800	2,900	4,000	6,400	7,000	6,100	3,200	1,600	1,200	900
Total	**min**	400	520	610	770	810	1,300	2,100	2,700	1,340	620	330	310
Total	**ave**	970	1760	2505	3035	3455	5250	6950	7150	3720	1610	1035	850
Total	**max**	1,540	3,000	4,400	5,300	6,100	9,200	11,800	11,600	6,100	2,600	1,740	1,390

Source: Ubell 1971. *See Figure 9, Figure 10.

social response during the mid-Holocene (Weiss and Bradley 2001, deMenocal 2001), proxy data useful for assessing the quantity and seasonality of precipitation at any given point in time remains rather thin on the ground. [41] Relevant to assessing headwaters contributions, one laminated annualized sediment core from Lake Van in eastern Anatolia has been analyzed in 80-year increments (Lemcke and Sturm 1997). The authors used changes in oxygen isotopes, strontium/calcium ratios, and magnesium/calcium ratios as proxies for paleohumidity, which was in turn taken as a proxy for precipitation. The resulting curve indicates a good deal of inter-centennial variability, but that conditions generally wetter than present prevailed 6200–2200 BCE.

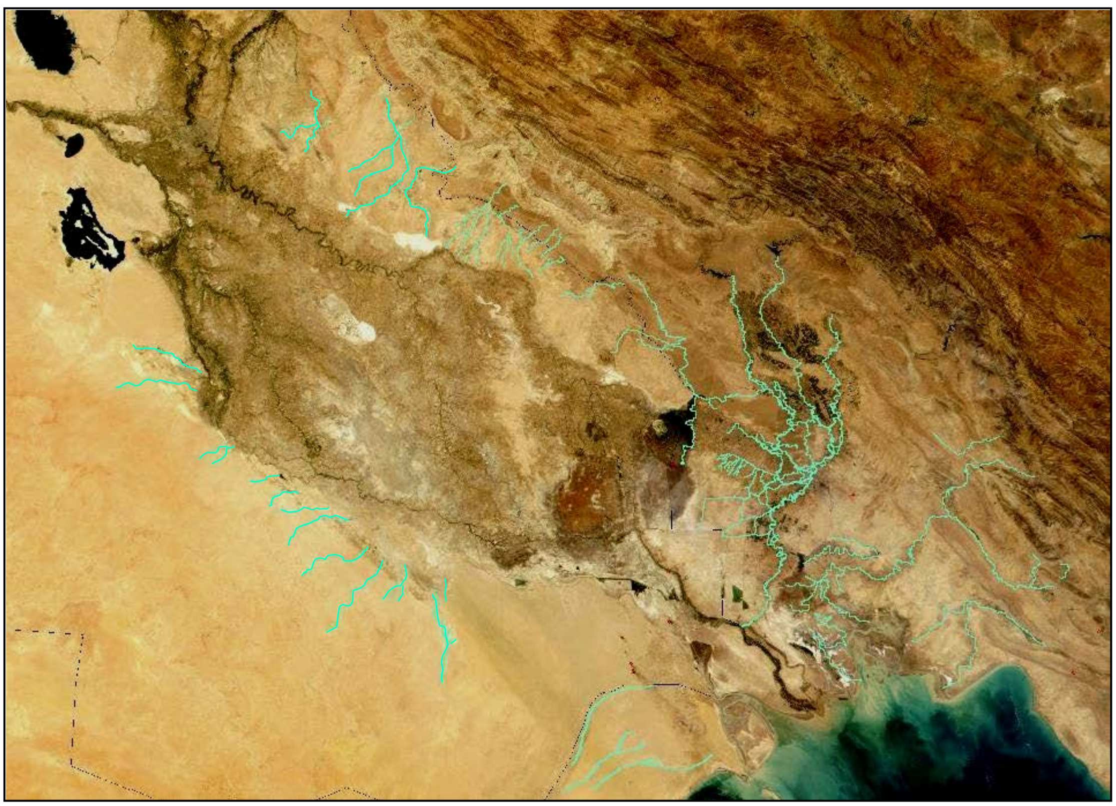

Figure 12: Alluvial drainage influenced by the Indian Monsoon.

[41] Critiqued in Pournelle 2001, Algaze and Pournelle 2003 (in press).

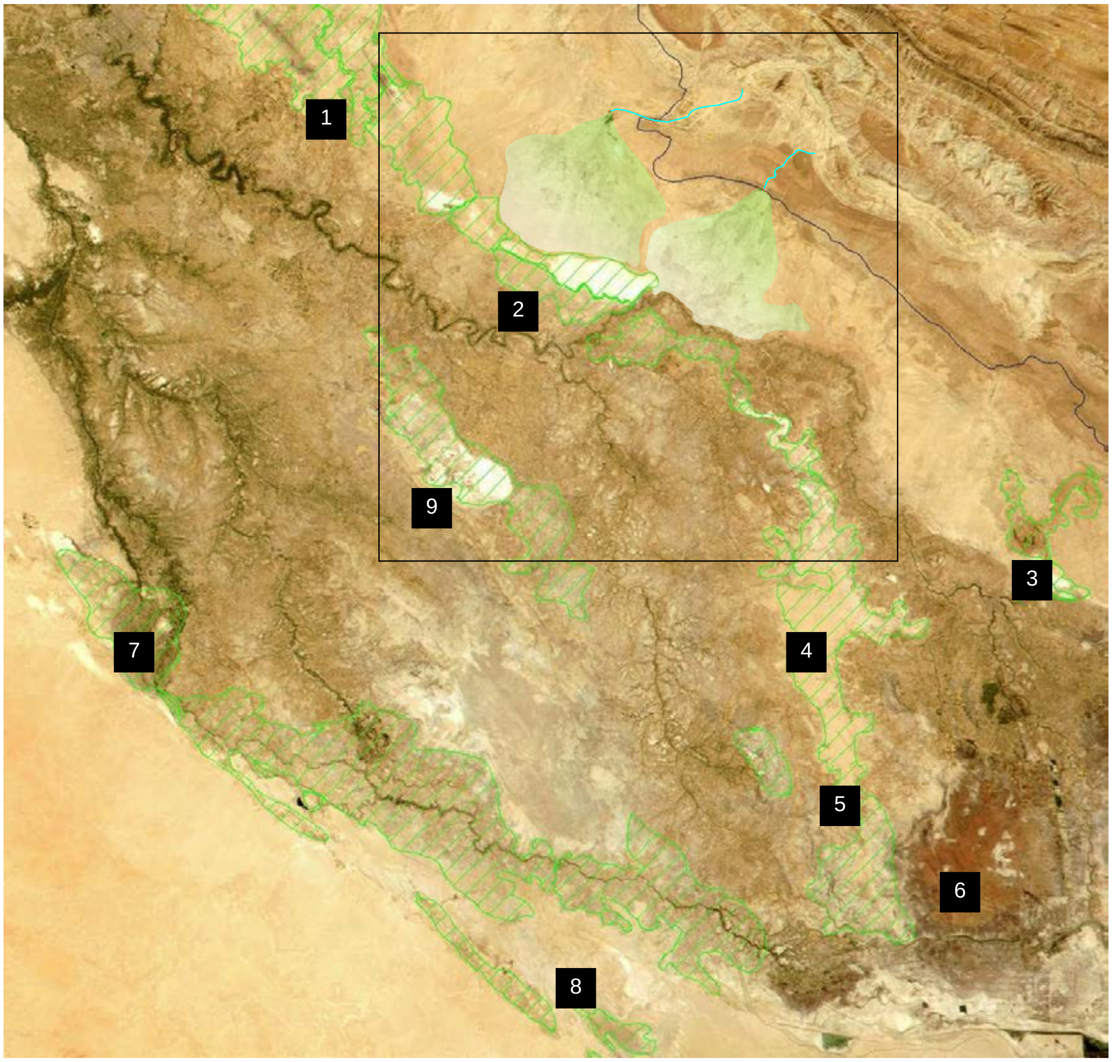

Figure 13: Alluvial boundary wetlands. Trapped between alluvial fans and the Tigris' raised floodplain, rainfall on the lower Zagros forms seasonal marshes (1, 2, 3). The Tigris has cut earlier fans, remnants of which (4) may demarcate former boundary wetlands (5). An extreme example of this process is the contribution of the modern Karkeh to the Hawizeh marsh. Rainfall also contributes to overall soil moisture and slows evaporation from the flood-prone region of channel and marsh formation, known locally as the Awhar (6). Monsoon conditions on the Arabian shield determine whether intermittent streams or aeolian dunes predominate in the Najaf (7) and Ur-Eridu (8) basins. Like old Euphrates courses along the south rim of this zone, the Dalmaj basin (9) may be a case where rivers captured an earlier wetland boundary. Boxed: see Figure 86.

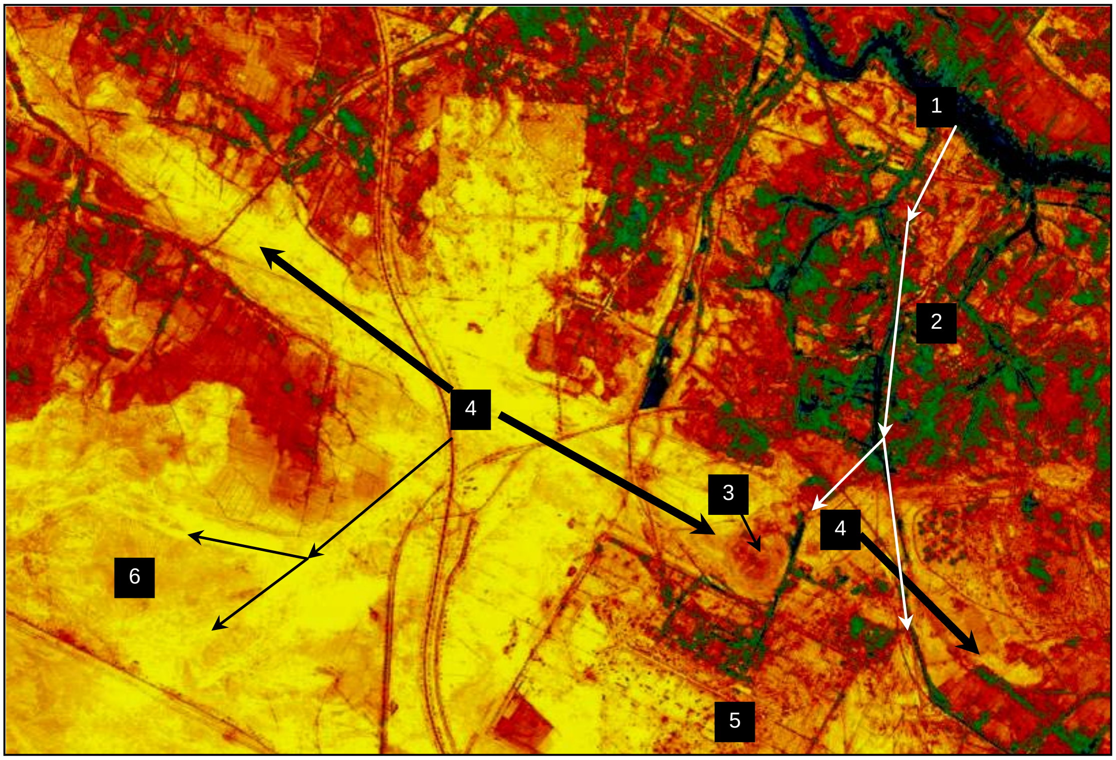

Figure 14: Ur. Fanning fern-like down the weak banks of the modern Euphrates (1) just west of Nasiriya, canals (2) skirt Ur (3) as they transect the dry, compacted soils (yellow) of a massive, relict levee system (4). Their tails drain into a slight depression, now boxed by an airfield (5), south of the high mound. Traces of similar irrigation/drainage systems overlay a relict sediment fan (6) southwest of the Ur levee. Except for Ur and a few other cultural mounds, nowhere in this scene does surface elevation vary by more than one meter. NIMA Panchromatic SPOT 10m DOI with ENVI™ 3.5 color table (Blue/Green/Red/Yellow), linear stretch (69:210) applied.

Thereafter, relative humidity declined below present-day levels until approximately 1000 BCE. Mann and Bradley 1998 have modeled Mediterranean storm track influences on Euphrates midstream tributaries, based on historical data collected over the past quarter-millennium. Other proxies have been derived from carbon and oxygen isotopes in Soreq cave spelothems and Negev land snail shells (Bar Matthews et al. 1998, 1999; Goodfriend 1990, 1991), and from Dead Sea salt cave levels (Frumkin, Carmi, Zak, and Magaritz 1994). These support the conclusion that mid-Holocene precipitation in upper Mesopotamia may have been up to 25% greater than present (Figure 14). [42]

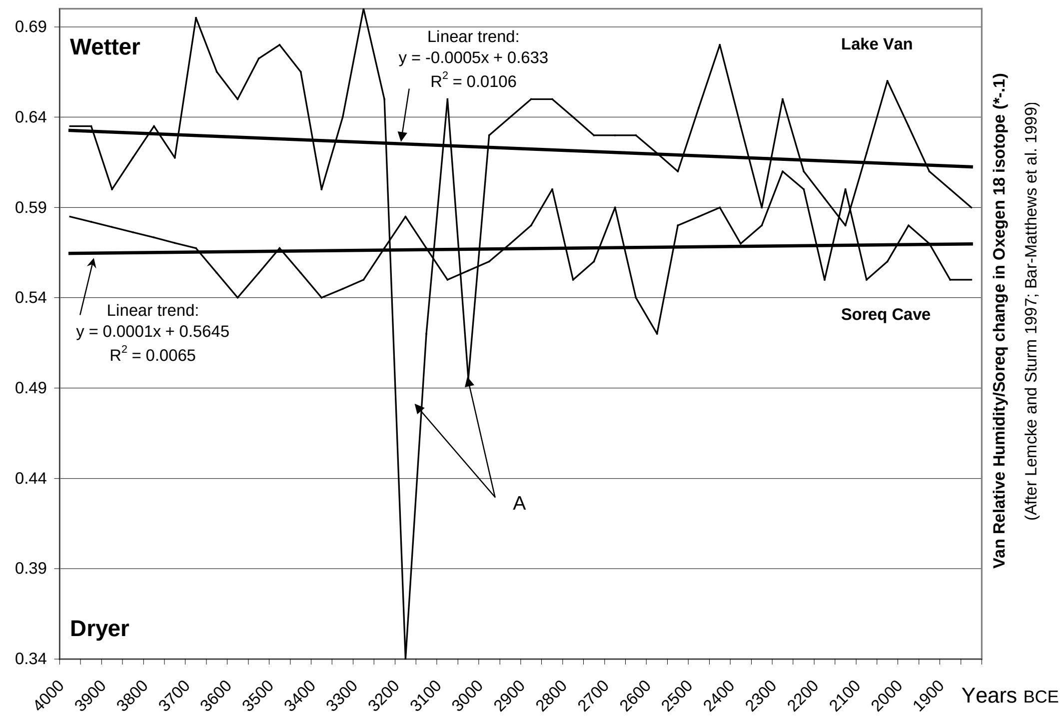

Figure 15: Fourth–Second millennium BCE climate regime, Upper Mesopotamia. Relative humidity proxies at Lake Van generally co-vary (although lag slightly), with those at Soreq Cave near Jerusalem, reflecting Mediterranean storm track north-south oscillations. However, the extreme Van core anomaly c. 3000–3200 BCE (A) is not reflected in the Soreq spelothem, making interpretation of this spike problematic. Van absolute values are based on 80-year slice averages, and neither proxy has been studied for annual or seasonal variance. General trends for the period indicate 10–25% higher precipitation than present day, with somewhat higher inter-centennial variability, suggesting the possibility of bi- or tri-centennial floods exceeding historically recorded peaks. Source: see text.

[42] Flooding and marsh recharge is primarily related to melting of headwaters snow packs. However, an increase in either early autumn (October–November) or late spring (March–May) precipitation, even south of the thirty-fourth parallel, reinforces and lengthens the regular flood seasons. Flooding and marsh formation associated with peak lower alluvium precipitation years occurred in 1870, 1894, and 1918–19. (MacFayden 1938; Roux 1960: 30–31).

Regarding direct monsoonal influence on the lower alluvium, Indian Ocean and Nafud desert lake cores in Arabia suggest a wet phase from the mid-seventh millennium BCE, followed by a steady drying trend beginning 4300–3700 BCE that reached present values some two millennia later (Cullen et al. 2000; Schultz and Whitney 1986; Lézine, Saliège, Wertz, and Inizan 1998). The monsoonal system may have been punctuated by centennial or bicentennial dry phases (Doose-Rolinski, Rogalla, Scheeder, Lückge, and Von Rad 2001), and was in any event characterized by extreme local variability. However, paleobotanical evidence from the Arabian shield also suggests that, in general, the early-mid Holocene (seventh to fourth millennia BCE) was considerably wetter than at present, and that especially during the late fifth millennium the Mesopotamian alluvium may even have experienced summer rains (el-Moslimany 1994; Hole 1998b; Miller 1998; Zarins 1990: 49–50). Stable isotopes extracted from Red Sea corals suggest that summer monsoon rains reached the northern end of that body from the mid-Holocene until as late as 2400 BCE, and support models suggesting increased seasonality and a northward migration of the monsoon over northeastern Africa and Arabia (Moustafa, Pätzold, Loya, and Wefer 2000). Calcium carbonate and dolomite dust deposits in the Gulf of Oman, taken as aridification proxies downwind of prevailing southwesterlies across the Arabian peninsula, indicate relatively stable dust depositions 4000–2100 BCE, with a spike 3200–3000 BCE, followed by slight but steady decrease (deMenocal 2001). The spike corresponds to a similar anomaly in the Van core (Figure 14), inviting an interpretation of pan-Mesopotamian drought during this period, but cannot be correlated with increased deposition in the Oman cores of terrigenous strontium isotopes associated with specifically Mesopotamian soils (Cullen et al. 2000), or with indicators of aridification in the Soreq cave (Israel) proxies (Bar-Matthews et al 1999). A better interpretation, accounting for the simultaneous decrease in eastern Anatolian humidity (Van), increased humidity in the Levant (Soreq), increased dust deposition in the Gulf of Oman —without a significant upper Mesopotamian fraction—and consistent with an increase in NAO sea surface temperatures and decreased NAO circulation strength is an extreme southward depression of the Mediterranean storm track during that period (Bond et al 1997, Cullen and deMenocal 2000; Cullen, Kaplan, Arkin, and deMenocal 2002). This would have deprived the twin rivers of upstream input, increased precipitation in the Levant (perhaps also increasing mid-stream Euphrates inputs), and increased (spent) dust-laden winds across upper Arabia and Kuwait.

In summary, throughout the period investigated in this dissertation, the southern alluvium and its neighboring boundary uplands may have experienced slightly more, and slightly less seasonalized, precipitation than now. Thus, on the alluvial margins, deserts *may*, during the climatic optimums, have become more like steppe land, steppe land more like savanna, and savanna more heavily wooded, than at present. Added to this, water volume flowing into the twin rivers' flood plains and deltas may have varied in the range of 10–25% greater than at present. Any further refinement of the paleoclimate record and its direct implication for habitation in the southern alluvium requires proxy data from that region itself, and—most importantly—a basis for interpreting perceived associations among human settlements, watercourses, and the landscape through which that water flowed.

C. Fluvial Processes

Seeking to understand the origins and development of civilizations in the alluvial lowlands of the Tigris, Euphrates, and their tributaries, over the course of two decades scholars from the Oriental Institute of the University of Chicago and the German Archeological Institute, Berlin conducted broad scale regional settlement surveys (Table 7, Map [Figure 90]) that located, recorded, and dated thousands of archaeological sites (Figure 15), using these to date the relict water courses that intricately lace the region (Adams 1981, 1965; Wright 1981; Adams and Nissen 1972;

Table 7: Twentieth Century Settlement Surveys in Alluvial Mesopotamia*

MAP NO.	AREA	REFERENCE
1	Diyala Region	Adams 1965, 1981
2	Akkad	Adams in Gibson 1972
3	Kish Region	Gibson 1972
4	Nippur Region	Adams 1981
5	Mashkan-Shapir	Stone 1990
6	Warka (Uruk) Region	Adams and Nissen 1972, Adams 1981
7	Uruk	Finkbeiner 1991
8	East Gharraf	Iraq Directorate of Antiquities 1976
9	Tello Region	Jacobsen 1954, 1969; Parrot 1954
10	Lagash	Carter 1990
11	Zurghal	Black 1990
12	Ur-Eridu Region	Wright 1981
13	Hammar Lake Region	Roux 1960

*Sources: Wilkinson 2001a: 224 and as listed. See Map (Figure 90).

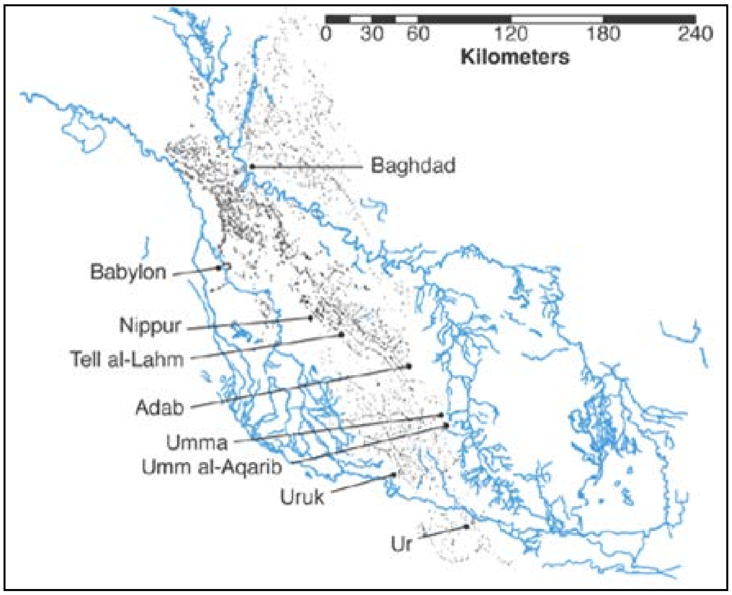

Figure 16: Archaeological sites of the central Mesopotamian alluvium, with twentieth-century Tigris–Euphrates drainage. This figure shows the sheer density of (known) surviving archaeological material indicating past settlement the in surveyed areas, and the sheer magnitude of discovery efforts to date. Source: Carrie Hritz, University of Chicago Oriental Institute–CAMEL. Used by permission.

Gibson 1972).[43] The surveyors were thereby able to provide a broad view of long-term settlement patterns and demographic changes in the Mesopotamian lowlands from the beginnings of settled towns to the present day. Adams' work is especially well-known for its clarification of how the natural environment of the area affected human life, what changing strategies Mesopotamian societies used throughout history to adapt to that environment, how successive Mesopotamian societies transformed that environment, and what selective environmental pressures existed in the region that favored the development of the world's earliest urban societies (Adams 1981). Prior to these studies, it had been generally thought that heavy alluvial deposits over the lowerMesopotamian alluvium would have made it impossible to determine the origins

[43] These extensive surveys have been supplemented by intensive surveys in the vicinities of Abu Salabikh (Wilkinson 1990), Mashkan-shapir (Stone in press; Wilkinson 2003), Larsa (Huot, Rougeulle, and Suire 1987), Lagash (Carter 1990) and Uruk (Finkbeiner 1991; Margarete van Ess, personal communication 2002).

of deeply buried cities (Nützel 1979). However, the surface surveys showed that this was not necessarily the case. In some cases, wind erosion periodically re-exposes long-buried artifacts that, when systematically collected, dated, mapped, and plotted with reference to ancient canal traces, reveal a distinct pattern of urbanization and extension of irrigation technology over a period of five millennia.[44] Thus, the corpus of archaeological survey data for Mesopotamia, although incomplete, has succeeded in adding a corrective rural and non-literate dimension to the predominantly urban, literate, elite focus of excavations and excavated historical cuneiform texts—which texts themselves have long influenced interpretation of the archaeological data.

A significant conclusion of Adams' work was that the present-day courses of the Tigris and Euphrates rivers are, geologically speaking, of recent and largely anthropogenic origin. Following Jacobsen's attempt to reconstruct the main watercourses of ancient southern Mesopotamia from textual sources (Jacobsen 1958), Adams undertook to identify actual waterways using extensive ground survey and KLM air photography. He argued that the late mid-Holocene courses of these rivers ran down a narrow corridor through what is now the lower alluvium, a corridor demarcated by ancient cities strung along relict water courses (Adams 1981: 6). In an attempt to overcome the inherently speculative problem of attaching precise geographical localities to watercourses named in early historic itineraries and other accounts, Adams documented thousands of now-deserted canals in association with these sites and hypothesized linear connections between them. He further argued that

[44] Discussed in detail in Wilkinson, 2003, Chapter 5. See especially Figure 5.7.

the accumulation of silt carried and deposited by these irrigation activities gradually aggraded the central steppe through which the progressively canalized rivers and canal off-takes ran, ultimately forcing the “wild” rivers respectively westward and eastward (Adams 1981: 14–22). Once abandoned, aeolian deflation of levees formed dune fields that then scoured their way across the plain. In many cases, this left archaeological features pedestaled above the deflated surface, that is, standing on columns of later sediments protected from deflation by archaeological debris (Wilkinson 2003).

While individual channels such as those studied and mapped by Adams from the KLM air photos are suited to localized study supported by ground-based geomorphological assessment, orbital scanners are more efficient for detection and analysis of paleochannels at a regional scale. This is especially true for the analysis of adjustments to discharge, sediment load, drainage diversions, and cataclysmic flooding (Baker 1986: 259). Thus, although the original air photos are no longer available,[45] declassification of late 1960s–early 1970s-era satellite photographs have allowed me to expand on his original work. By mapping comprehensively the archaic

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[45] Three accessible copies of the KLM mosaics are known to have existed as of 1979: One, held by Hunting Surveys Ltd. and its successors, and utilized for its numerous development contracts in Iraq, was discarded by company librarians in 1989. A few frames of this set, along with related geomorphologic assessments, were salvaged by Mr. Neil Munroe and are held privately in Scotland. I was fortunate to have the opportunity to consult these in 2002. A partial second set, held for field reference at the German Archaeological Institute excavation house at Warka, disappeared (perhaps confiscated by the now-defunct Iraqi Army) some time before 2001. The whereabouts of the original set, made available to Adams for field use by the Iraq Director General of Antiquities in the 1960s and 1970s, is unknown. Air photographs of the Eridu basin were available from the Iraqi Ministry of Defense in 1969; their fate is also unknown.

courses of the Tigris and Euphrates, from Samarra to ancient Ur, I herein attempt to establish the courses of entire, connected systems. Associating these with periodized sites (Chapter Four) helps to clarify channel dates and anthropogenically-driven geomorphology in a comprehensive fashion impossible through the analysis of individual localities.[46]

Of particular interest to this study are characteristics of river metamorphoses closely related to regional tectonic movements. As the surface slope of alluvial channels levels off enroute to the sea, the river beds undergo threshold changes from braided, to meandering, to straight or sinuous, with the latter in some cases assuming multi-channel, anastomosed patterns (Baker 1986, 257–259 and figs. 4–5; Schumm and Khan 1972). In Mesopotamia, braided channels are typical of the arid uplands, where the Tigris and Euphrates are deeply incised into the Syrian and Arabian plateaus. However, on dropping from the stable shelf lands into the alluvium, their slopes abruptly diminish to less than one percent, and they assume meandering courses within relatively stable banks through a river floodplain (Figure 16).[47]

Relict river meanders leave fossil traces up to several kilometers in width,

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[46] I do not by this mean to discount geomorphologic studies of localized canal systems. Extensive local testing and ground-truthing are essential to building accurate imagery interpretation keys, just as extensive regional survey cannot be fully interpreted without localized, intensive, total coverage survey. Campaigns resumed at Warka in 2001, and excavations opened at Umma in 2002, may hold forth the possibility of testing the hypotheses presented herein in the near future, although at the moment political and security conditions remain unsettled, and widespread looting is causing alarming damage to site contexts.

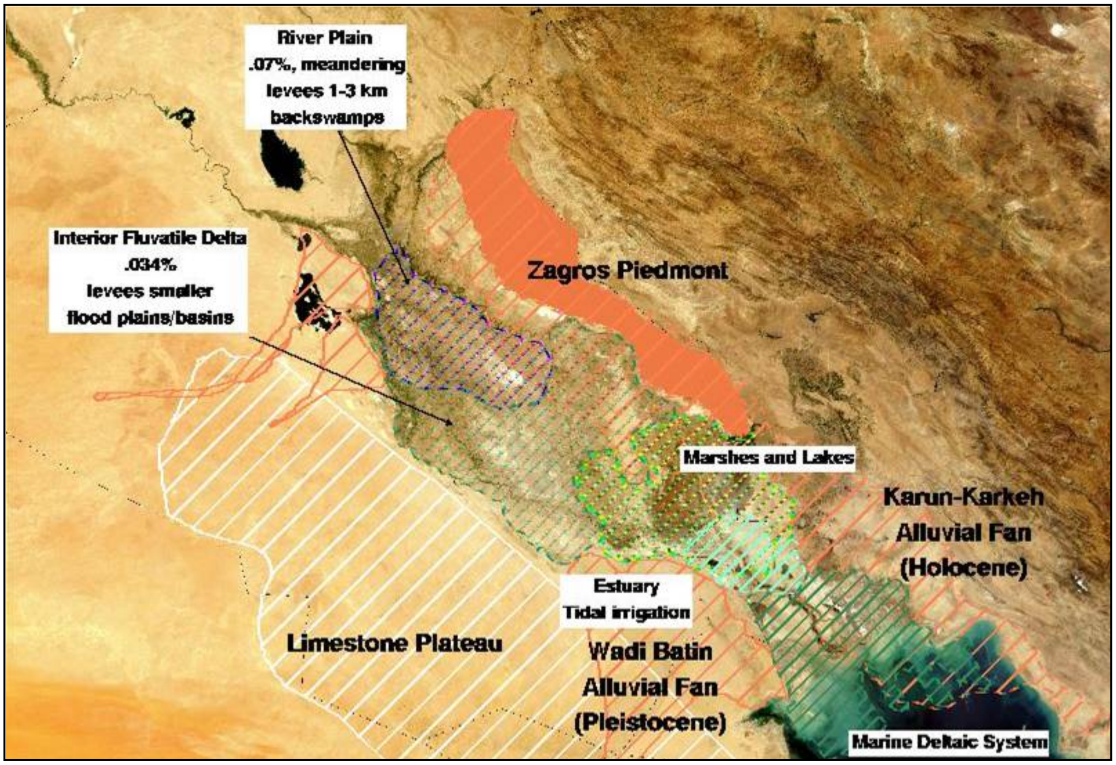

Figure 17: The Shatt al Arab Deltaic System. After Verhoeven 1998, Sanlaville 2003.

characterized by concentric, bending stripes on their crests (Gasche and Tanret 1998: 5–7). Their contours can be preserved for millennia, due in part to their durable function in shaping subsequent agricultural systems as they delineate systems of irrigation dikes and levees that hold recessional silt and demarcate field and crop boundaries. The breadth and periodicity of relict meanders was determined by channel size, sediment load, bank resistance and volume and flow rate of water discharge (Verhoeven 1998, Short and Blair 1986: 257, Adams 1981: 8–9), aiding identification of system components and comparison to modern systems. Down the upper

[47] See Verhoeven 1998: 175 (fig. 3) on the interaction of sediment load with stream power, flow velocity, and gradient to determine channel pattern and stability.

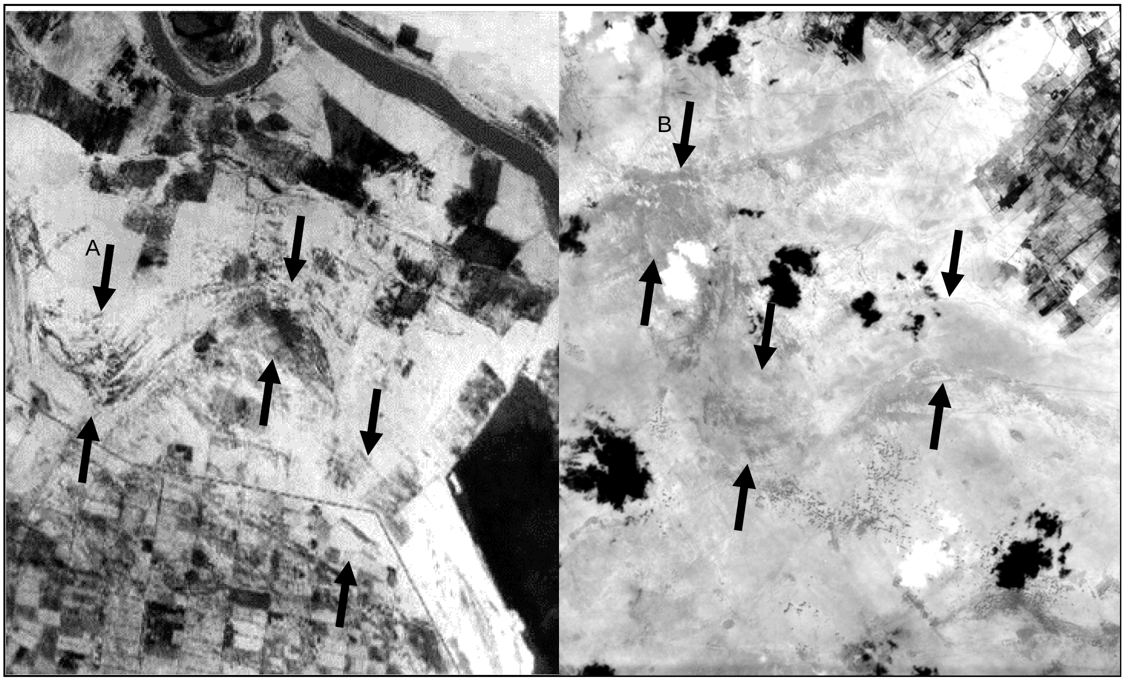

Figure 18: (A) Modern Tigris east of Kut (dark line across top). To the south, relict ninth century CE meander course skirts modern development. (B) Relict meander course appears to weave between white clouds and dark shadows northeast of Nippur. CORONA KH4B_1103-1A-D041-058; KH4B_1103-1A-D041-054 (May 1968)

Mesopotamian alluvium, meandering systems are visible within the relatively narrow belts of their archaic flood-plains. (Figure 17B). Between Samarra and Adab, relict meander belts charted on CORONA correspond to interconnecting watercourses posited by Adams and others (Stronach 1961, Adams 1981: 16–17, Adams and Nissen 1972, Wilkinson 1990a). The belt here depicted (located northeast of Nippur, now drowned beneath the artificial Lake Dalmaj) is of particular renown. Adams dated this succession to the fourth millennium BCE, by association of numerous sites along its bends (Adams 1981: 62, fig. 11).

On passing from the Tigris sub-zone syncline to the Euphrates sub-zone monocline, slope falls to less than one-half percent. There, especially along transecting slip faults, the rivers tend to branch into multiple sinuous distributaries with weak banks. The Lake Dalmaj channel succession (Figure 17B) is comparable in size and periodicity to a main branch of the modern Tigris channel just downstream from (east of) the al-Kut barrage, which diverts considerable flow to maintain the older Shatt al-Gharraf (Figure 17A), a branch of the Tigris system active during the first millennium CE, until the sixteenth century when the river assumed the modern course as its main channel (Buringh 1960: 182; Plaziat and Sanlaville 1991: 342).[48] Not only does this reach of the modern Tigris, located at the transition from a meandering to a sinuous system, have characteristics of both; like the Dalmaj succession, it approximately follows the sub-zone boundary. While this says nothing about the date of the Dalmaj succession, it does argue for the possibility of its being an analogous distributary of the Tigris. However, neither can we rule out an earlier (Pleistocene) dating for this relict channel, later exposed by aeolian deflation leaving subsequent Holocene sites pedestaled on its surface. (Wilkinson, personal communication, 2002). I will return to this problem in the discussion of sediment deflation, below (page 138).

Especially for sinuous channels (which leave no or few relict meander scrolls), alluvial levees, avulsive splays, and deltaic mouths help to chart and date a relict fluvial system in its entirety. Since alluvial soils constitute the best agricultural soils (Buringh 1960; Wirth 1962), direct association of these with (datable) past human activity can be quite common. Over time, flood deposits along riparian distributaries

[48] The lower Gharraf comprises a modern delta overlying older channel beds (Buringh 1960: 185). After silting up, one of these was probably re-dug by Etema of Lagash during the third millennium BCE (Lloyd 1955). See Figure 21, Figure 22.

build apparently massive but where the conjoined rivers form an estuary famed for its millions of date palms nonetheless relatively weak levees. Today, the largest of these line the Shatt al- Arab, (destroyed during the Gulf Wars) (Figure 18). Levee material, compacted over time by fluvial action, is less water-permeable than adjacent unconsolidated silts and waterlogged depressions. In arid zones, as the water table rises during spring floods, on panchromatic (black-and-white) photographs levees therefore appear as brighter and lighter in color than surrounding soils (Figure 19). Chains of sites situated along and on top of such levees can indicate the system date.

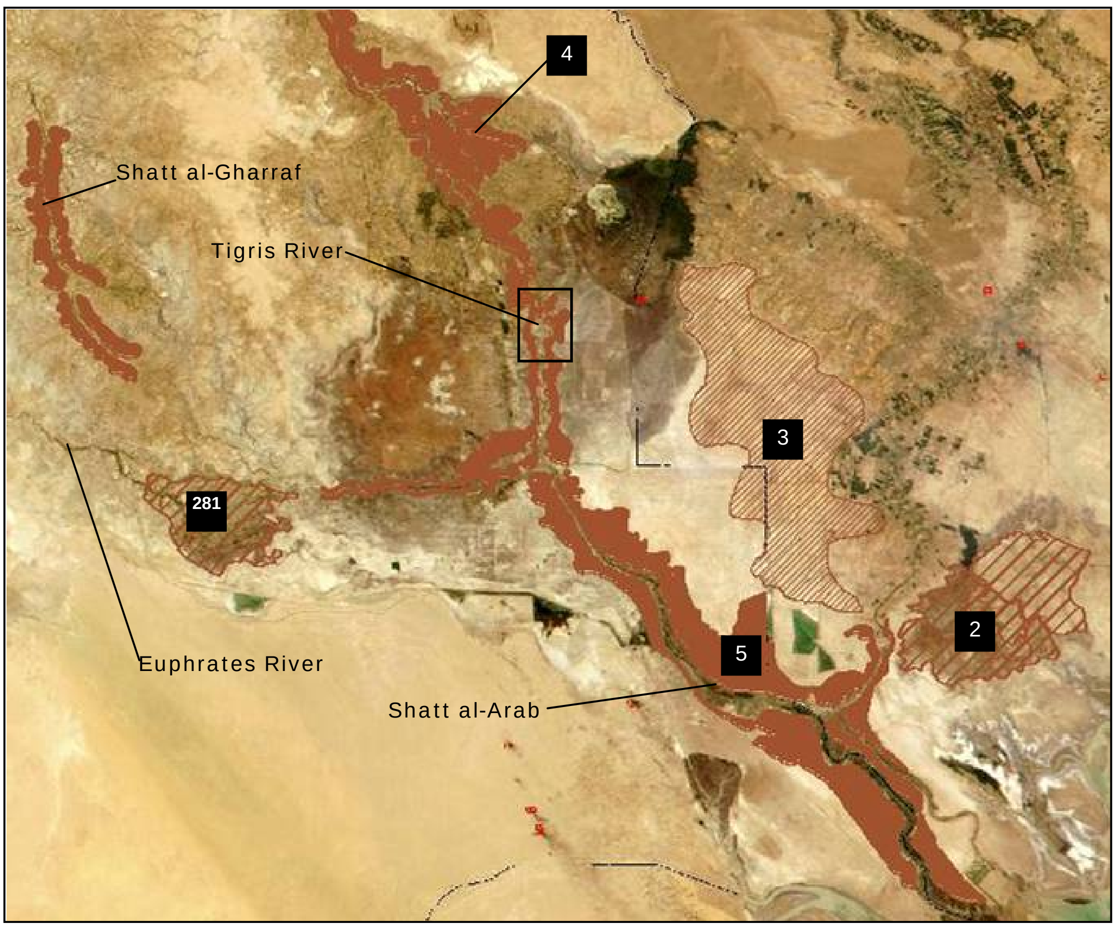

Figure 19: Contemporary (1) Levees; (2) Crevasse Splays; (3) Alluvial Soils (4) Bird's Foot Delta. Box: see Figure 19A.

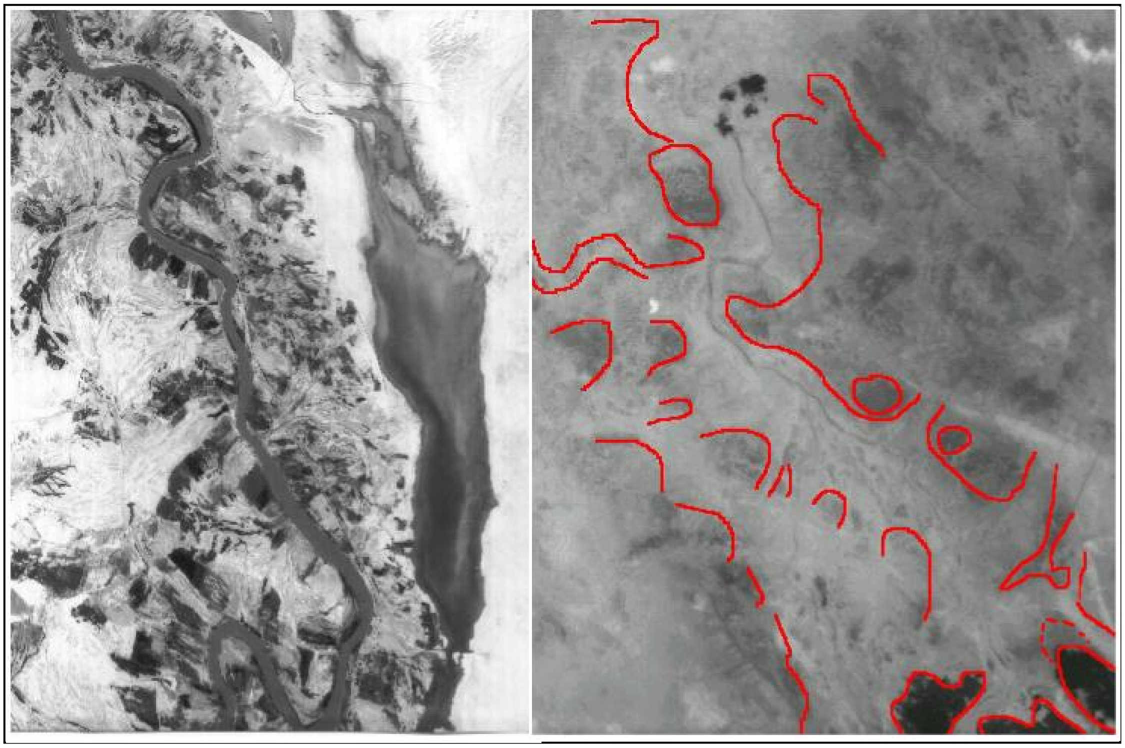

Figure 20: (A) Tigris south of Amara (Qalat Salih–al-Azair). The cultivated agricultural zone extends outward from the water channel along the levee system. Excess water drains through light-colored tails of smaller canal levees into seasonal back swamps visible as silty, dark grey bodies. Only two centuries ago these rice fields were year-round marshlands (Westphal-Hellbusch 1962: 39–40). (B) Red outlines demarcate relict levee between sites WS375–WS400. Better-consolidated levee soils are less waterlogged, and hence appear lighter in color.
KH4B_1103-1A-D041-055; KH4B_1103-1A-D041-058 (May 1968)

Two relict five-kilometer-wide levee systems extend through the now-arid Warka Survey area (Figure 20). One (B–D) runs south-southeast from meander traces recorded by Adams near site WS175 (B), to a series of distributaries dissipating into relict marshland from site WS427 to WS447 (D).[49] Particularly clear is a section between sites WS375–WS400, showing relict back swamps and off takes for near-

[49] WS: Warka Survey (Adams and Nissen 1972); NS: Nippur Survey (Adams 1981); ES: Eridu Survey (Wright 1981).

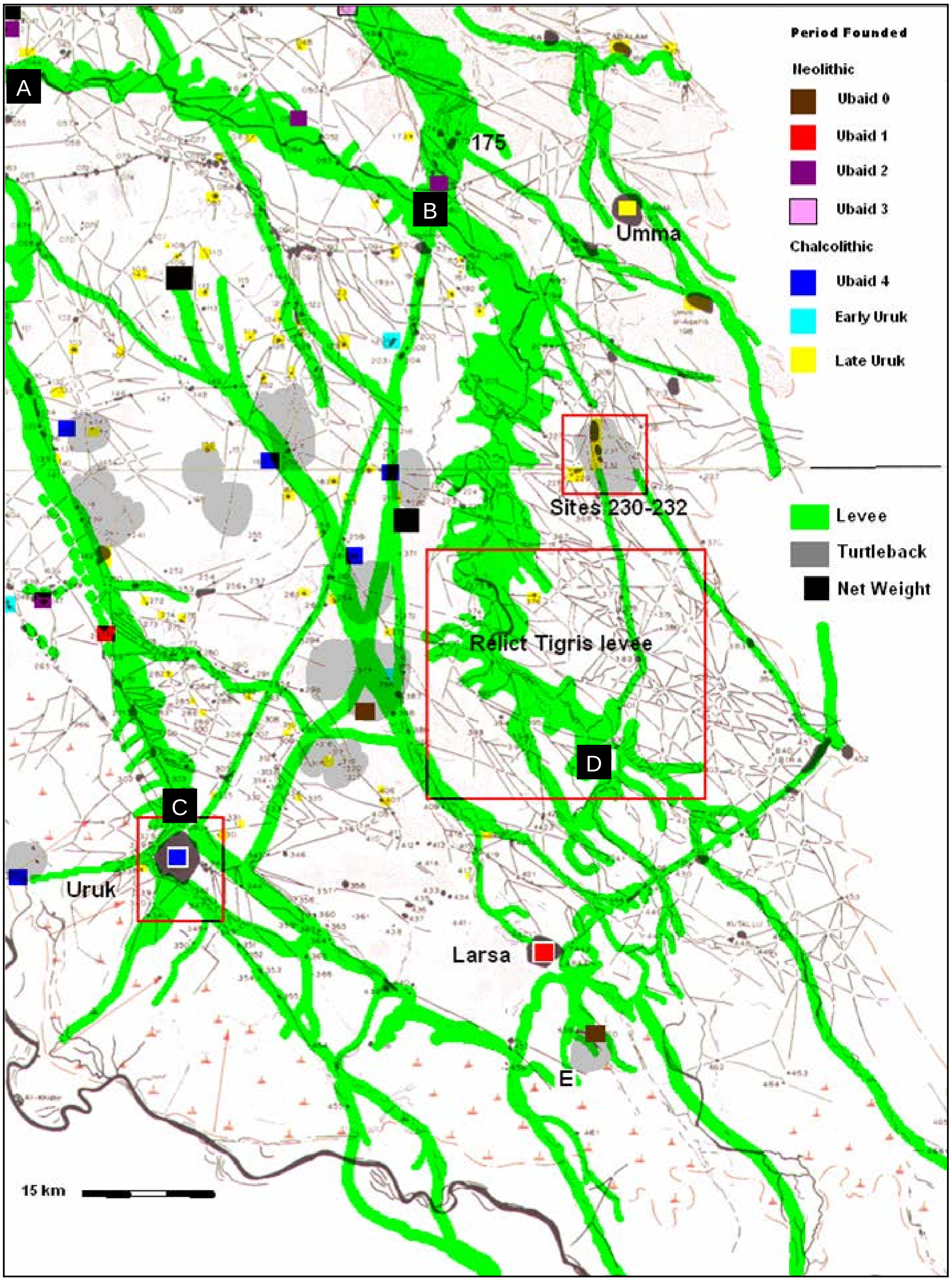

Figure 21: Relict levee systems, Warka Survey Area. Levees charted from CORONA imagery registered to Adams 1981 settlement surveys. Boxed: see Figure 19B; Figure 24B; Figure 74B. Channel dates: Figure 25, Figure 57, Figure 60, Figure 75.

levee cultivation. The thin, black line of the Shatt al-Khar is all that remains to indicate that a once-mighty watercourse flowed here. The Shatt al-Khar, a canal running atop the levee, (A–B–D) could not have transported sufficient silt to build themassive geologic structure depicted at Figure 19B. The width of these eroded natural levees indicates a past discharge capacity equivalent to that of the Shatt al-Gharraf, now maintained as a Tigris distributary by the al-Kut barrage, or of the modern-day Tigris south of Amara (Figure 19A). The second levee (A–C) underlies the Tullul al-Hammar/Banrat al-Hassan canal: again, a waterway of historical date (and proportions) that could not have built the levee atop which it runs. This would appear to have been the main water supply to Uruk (Warka), conspicuous by its desiccation after Old Babylonian times, when the city fell into decline. Subject to several re-engineering attempts, its course was apparently deepened and straightened during the Parthian–Sassanian periods of the early first millennium CE (Adams 1981).[50]

In the East Gharraf survey area, during the 1950s aerial photographic surveys were extensively ground-truthed by engineers contracted to rejuvenate the Gharraf irrigation system following construction of the Kut barrage in 1939. In soil test pits, ancient land surfaces can be distinguished from their 1–4m-thick overburden of recent

[50] More precise dating is discussed in Chapter Four. Crucial to its dating is determining if and when it supplied water to the "northeast–southwest canal" through the city (Finkbeiner 1991: table 19), or to Uruk-period brick canals excavated in the Eanna precinct (Hemker 1993 I:39–42; II: 138–146). That it is of at least second millennium BCE date is suggested by Ur III itineraries linking Uruk to Shurrupak (Steinkeller 2001).

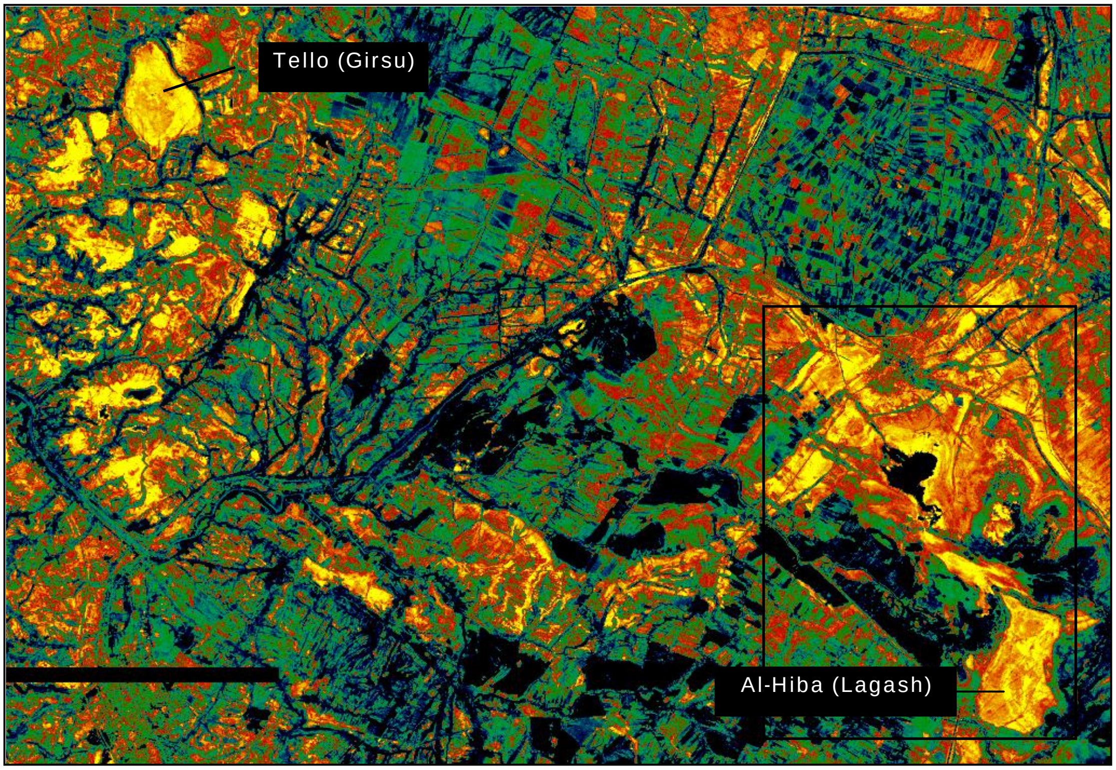

Figure 22: Tello Survey Area. Compacted archaic levee soils appear yellow. NIMA Panchromatic SPOT 10m DOI with ENVI™ 3.5 color table (Blue/Green/Red/Yellow), linear stretch (69:210) applied. Box: See Figure 83.

sediments by their darker color and more compact structure, texture, and consistency (Buringh 1957b: 31). Various levee soils, although undated, were distinguished and mapped as “modern” or “ancient” (Cotha Consulting Engineers 1959: fig. 3.1). Panchromatic SPOT imagery enhanced with ENVI false-color tables is extremely useful for distinguishing these archaic structures from surrounding modern agricultural activity (Figure 21). Superimposed CORONA photographs made it possible to distinguish separate depositional layers (Figure 22), notably levees and an apparently related avulsive node near Umma, on the eastern boundary of the Warka Survey Area.

Avulsions can become the source of new or diverted main channel flows, although as often the sudden fanning drops sufficient alluvial silt that as floodwaters

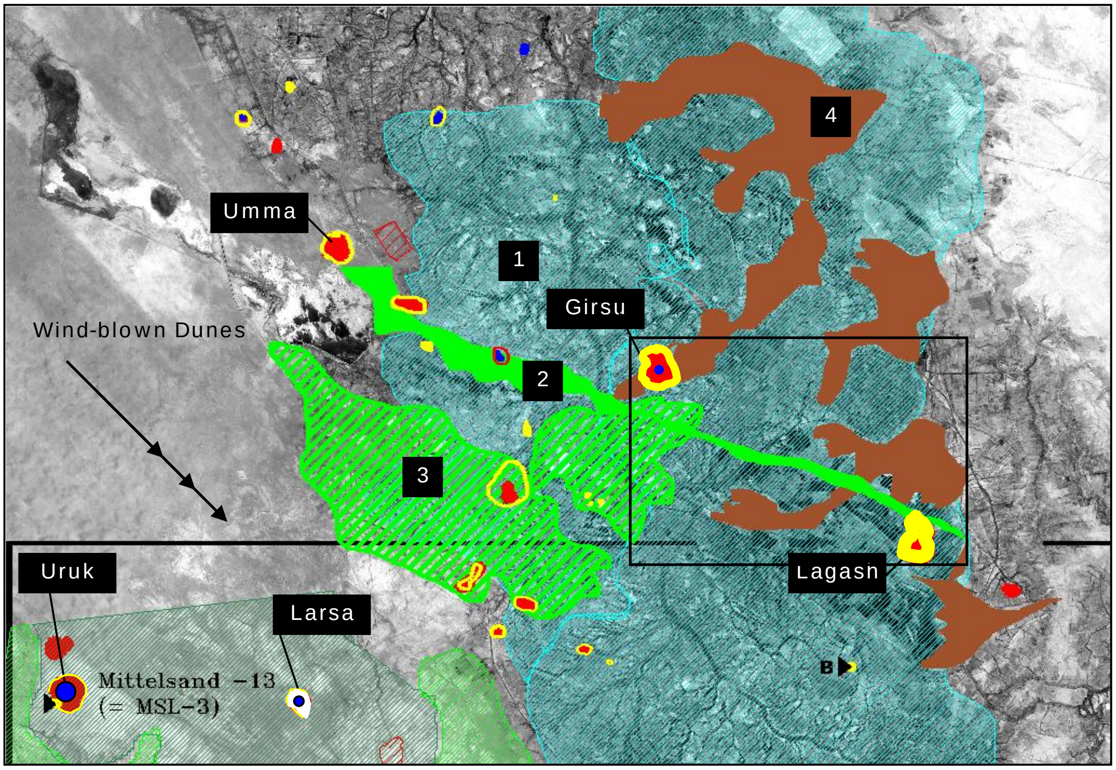

Figure 23: Lower East Gharraf Sediments, with earliest settlements dated by surface remains. (1) Present-day Gharraf levee and irrigated cultivation zone. (2) Relict levee, trending southeast from Umma. (3) Alluvial soils. (4) Archaic levees. (1, 4) after Cotha 1959. Boxed: see Figure 21. Earliest (known) occupation: Blue: ‘Ubaid; Red: Uruk; Yellow: Early Dynastic (Iraq 1976). NIMA SPOT 10m DOI, 1991. Box: see Figure 21; also Figure 83.

recede the natural levees may reestablish (Figure 23A). Sites located on top of flood-splays, where dramatic annual flooding would make permanent habitation exceedingly hazardous and unlikely, can serve as a *termini post quem* for active inundation from the breach, aiding in dating the system of which they form a part (Figure 23B).

Active sediment deposition as rivers abruptly slow on encountering slack water results in the multiple, bifurcating channels of a “bird’s foot” delta, with newly-forming sediment deposits creating webs between the toes, such as those surrounding Warka. The satellite photos reveal the city’s placement not so much on the river as in

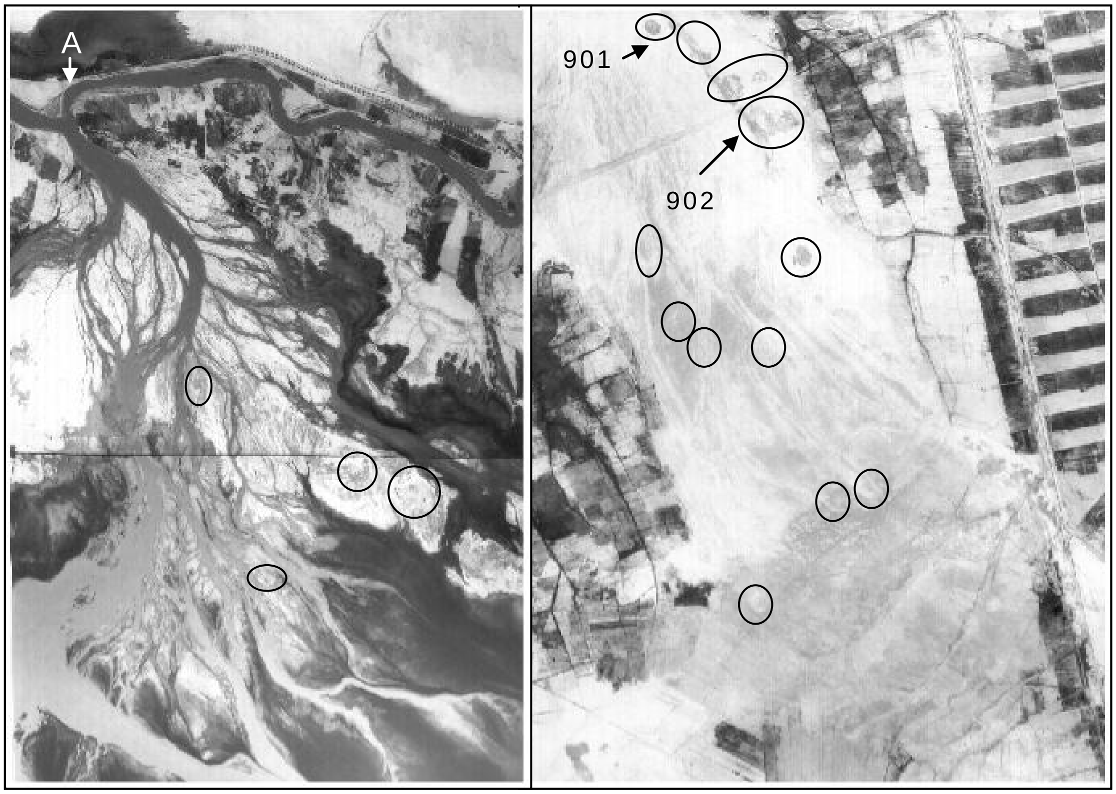

Figure 24: (A) The Kut barrage on the Tigris between Sheikh Sa'ad and Ali al-Gharbi drains floodwaters into Lake as Sa'adiya. The barrage maintains and augments a natural avulsion (flood splay) (compare Buringh 1960: 181). As flood waters recede, wetland villages (circles) stockpile fodder (reeds and grasses), and transhumant pastoralists graze livestock enroute to the Zagros piedmont.

(B) Flanked by modern fields, a relict avulsion south of Wilaya is cross-cut by more recent Parthian–Sassanian canals associated with sites WS901 (Tell Abu Khay) and WS902, dated to the first–second century CE (Adams 1981). Sites (circled) within the splay are unsurveyed, but Stone 2002 dates the relict Tigris watercourse that fed it to Isin-Larsa/Old Babylonian (second millennium BCE).
CORONA KH4B_1103-1A-D041-050/51; KH4B_1103-1A-D041-052 (May 1968)

it: the city's walls are clearly surrounded by a relict bird's foot delta extending into spring 1968 Euphrates floodwaters (Figure 24B).

In an attempt to reconstruct relict watercourses in their entirety across the full extent of areas where they might be associated to datable settlements, I conducted

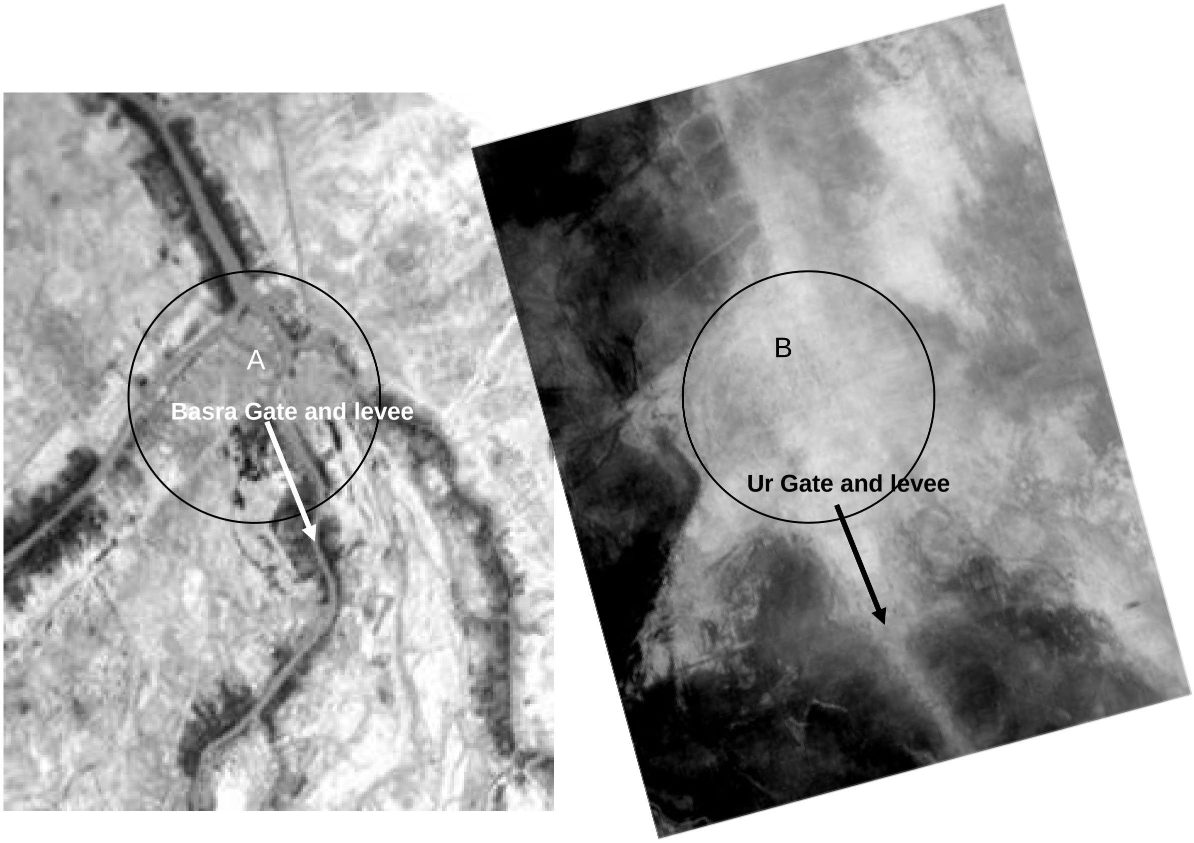

Figure 25: (A) Amara, straddling Tigris distributaries arrayed in a “bird’s foot” delta rapidly built outward into surrounding marshlands by riverbank rice cultivation (Buringh 1960: 187). Rice cropping is not thought to have been introduced before the late first millennium BCE (Ghirschman 1954), although it was practiced in the Indus valley at least a millennium earlier (Chakrabarti 1994).
(B) Warka (ancient Uruk), straddling a relict bird’s foot delta extending into spring Euphrates floodwaters (black). As late summer heat dries surrounding marshes and lowers the water table, lower areas and infilled drainage are marginally wetter, and therefore darker. Less permeable, higher, and dryer built-up areas, levees, and consolidated canal beds appear lighter in tone. See also Figure 76.
CORONA KH4B_1103-1A-D041-065 (May 1968); KH4B_1107-2170DA-139 (August 1969).

multiple mappings,[51] and compared the results to other recent independent efforts based on radar and auger transects (Gasche and Tanret 1998), SPOT (Verhoeven

[51] (1) MODIS, DTED/DEM for the entire alluvium; (2) CORONA, for the Tigris and Euphrates sub-zones; (3) SPOT, for the Euphrates and Basrah sub-zones; and (4) ASTER, for the Warka and Nippur Survey Areas.

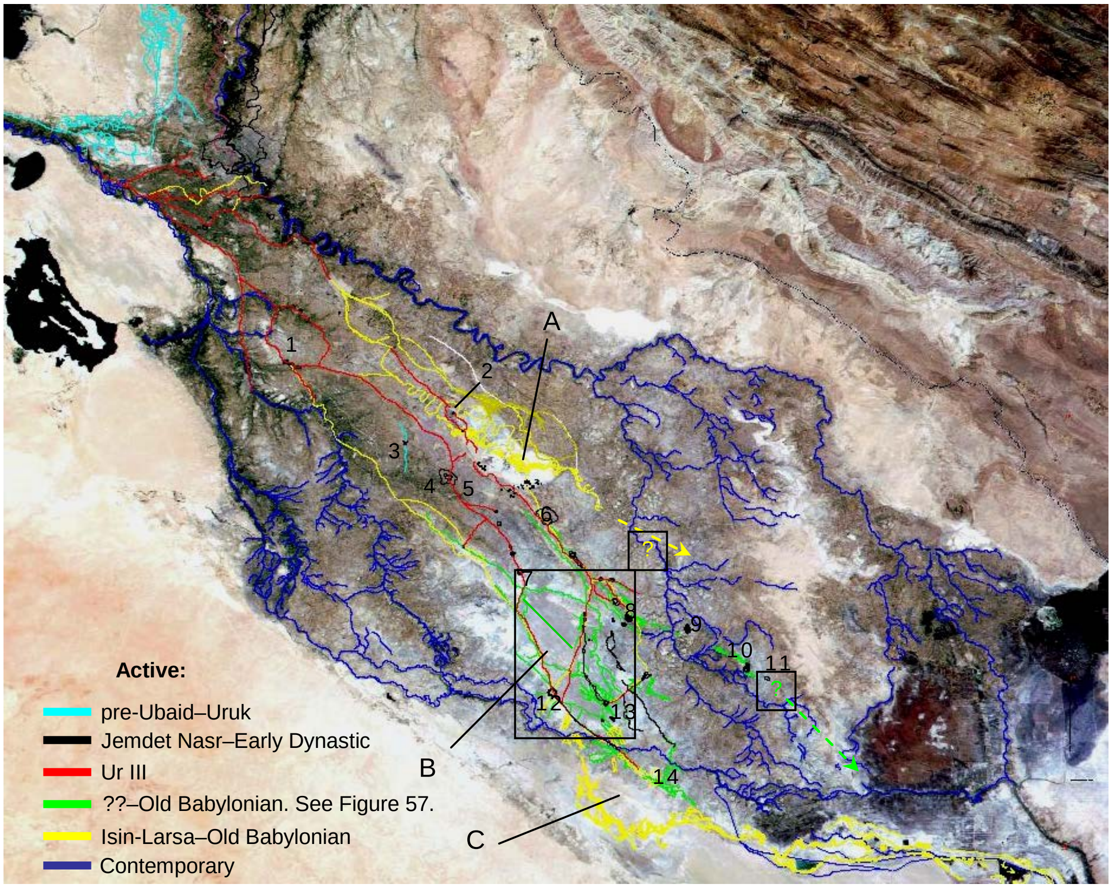

Figure 26: Tigris and Euphrates Alluvial Watercourses, 8000–1720 BCE. Only fragments remain, especially where later canals have re-used old levees. These are especially clear in the (A) Dalmaj, (B) Umma-Warka, and (C) Ur-Eridu flood basins, where aeolian deflation has removed soft surface sediment (see p.138).
1. Kish 2. Mashkan-shapir 3. Abu Salabikh. 4. Nippur. 5. Puzrish-dagan 6. Adab. 7. Shurrupak. 8. Umma. 9. Girsu. 10. Lagash. 11. Nina. 12. Uruk. 13. Larsa. 14. Ur.
Boxed: Figure 20, Figure 57, Figure 75.

1998; Stone 2002) CORONA (Hritz 2003), and textual analysis (Gasche and Tanret 1998; Steinkeller 2001) (Figure 25).

These recent attempts to reconstruct portions of the major fluvial systems from Samarra to Sippar (Northedge, Wilkinson, and Falkner 1989), from Sippar to Kish and Babylon (Cole and Gasche 1999), in the vicinity of Abu Salabikh (Wilkinson 1990), from Isin and Mashkan-Shapir to Ur (Stone 2002), in the vicinity of Nippur (Hritz

2003), and from Nippur and Mashkan-Shapir to Uruk (Steinkeller 2001) paint a revolutionary picture of the Tigris's overall contribution to alluvial settlement and irrigation during the third and second millennia BCE. Confounding earlier ideas about the primacy and importance of "Euphrates" waters that trace their source to the Anatolian Taurus, at their point of emergence onto the alluvium from the eighth millennium BCE the twin rivers appear to have had anastomosing and significantly intermingled flows. There is no evidence that they established their present meandering channel beds at the latitude of Felluja and Baghdad before the early second millennium BCE (Verhoeven 1998: 160), and even then at least one branch of the Euphrates still flowed eastward to the Tigris (Gasche and Tanret 1998).

By painstakingly reconstructing Ur III-period (late third millennium BCE) travel and shipping itineraries from Umma, Piotr Steinkeller has shown that a watercourse thought by textual scholars to represent 'the eastern branch of the Euphrates' (Jacobsen 1960) was known at Umma as the Tigris (Idigna), but that the major channels of the twin rivers still flowed so closely together that direct interconnection was maintained, possibly just south of Mashkan-shapir (Steinkeller 2001).[52] Admixtures notwithstanding, any estimate of water discharges along the courses mapped in this study must conclude that the *bulk* of the waters passing through Umma's surrounding wetlands by today's etymology too would be named Tigris distributaries. Thus, the primacy of Isin, Kish, and Babylon during the early–

[52] Stone 2002 critiques details of Steinkeller 2001, but agrees that the "Eastern Euphrates" attested in third millennium BCE texts was in fact a Tigris distributary.

mid second millennium BCE demarcates progressive westward (Euphrates) and eastward (Tigris) channel succession. As the climate dried and became more seasonalized, that succession privileged the (to those cities, proximate) Euphrates as a source of irrigation water, fostering the pearls-strung-through-the-desert view handed down through historical periods.

This leaves in question whether, where, and to what extent it is possible to associate relict channels with earlier (prehistoric) periods. The Ur III Tigris/Euphrates admixtures could have existed in substantially the same beds for millennia. Conversely, subsequent sediments and channel migrations may have obliterated any (surface) remains. The answer to this question, pursued in Chapter Four, impacts the scale of any undertaking to manage or divert water flows. Unsurprisingly, Tigris peak surges at Baghdad have proven unmanageable during much of the past century. Even the gentler Euphrates has at times proved too tempestuous for the best of Ottoman and British engineers. A catastrophic 1918 flood destroyed new head works, diverted the main channel to its most westward branch, and stranded vast tracts of farmland and palm groves, bereft of water along its Hilla reach. Such events have encouraged the presumption that the dangerous Tigris, carrying four times the water volume of the Euphrates (Figure 10), must have remained well beyond the reach of active exploitation until tapped by imperialist schemes late in the first millennium BCE. But beyond the meandering river flood plain, where the watercourses bifurcate at nodes of avulsion, flows become more manageable. Compare, for example, Figure 9 to Figure 26. Combining both waterways into a single, unmediated channel would create a

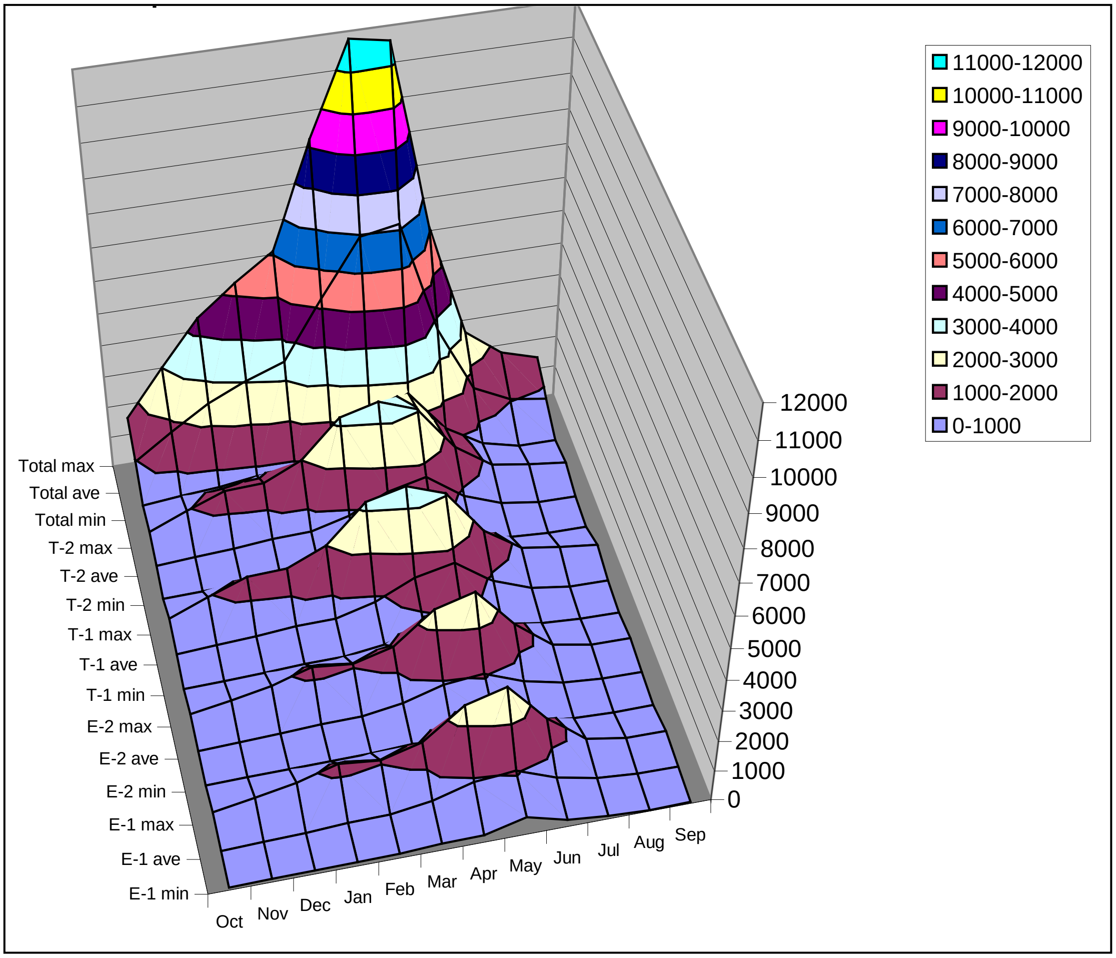

Figure 27: Tigris and Euphrates mean monthly discharge rate (million cumecs), 1931–66, with two (hypothetical) equal distributaries each. See Table 8.

potential nightmare of runaway flood peaks scouring and down-cutting through the alluvium—as prevailed during Pleistocene pluvial periods (Sanlaville 2003). But within the deltaic zone, avulsive bifurcations—even if into only two hypothetical distributaries—mediate downstream Tigris flow, reducing even *maximums* along either watercourse to below that of *average* combined Euphrates outflow. Any decrease in the seasonality of precipitation would further reduce flood peaks. Manageability is thus a combination of both “natural” fluvial processes and any human engineering that tends to reinforce channel anastomosis, such as bank cutting, as illustrated at Figure 23A and Figure 24A, and further discussed following p. 138, below. An extreme case of this principle is the engineered "Third River," completed in 1992, which receives its inputs, following regulated upstream dam releases, from irrigation tails—eliminating Euphrates flooding altogether. To better understand this interaction, we must therefore examine deltaic formation, and processes of sediment deposition and deflation.

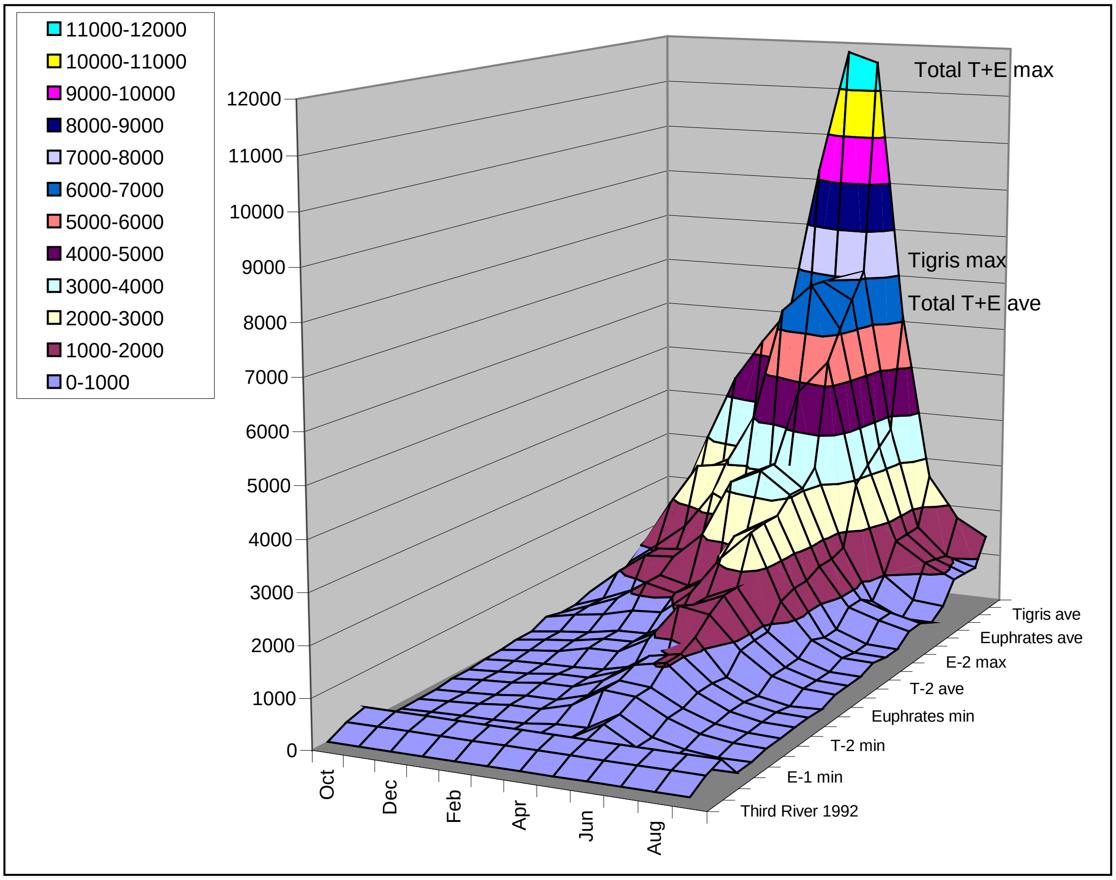

Figure 28: Tigris and Euphrates monthly discharge (million cumecs), including hypothetical distributaries, compared to modern Euphrates flow. See Table 9, Table 10.

Table 8: Tigris and Euphrates mean monthly discharge rate (million cumecs), 1931–66, with two (hypothetical) equal distributaries each.

Distributary		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Euphrates-1	**min**	95	120	130	140	155	230	250	600	245	100	40	50
E-1	**ave**	153	200	240	315	328	535	925	1050	548	260	145	130
E-1	**max**	325	550	800	1200	1050	1400	2400	2750	1450	500	270	245
E-2	**min**	95	120	130	140	155	230	250	600	245	100	40	50
E-2	**ave**	153	200	240	315	328	535	925	1050	548	260	145	130
E-2	**max**	325	550	800	1200	1050	1400	2400	2750	1450	500	270	245
Tigris-1	**min**	105	140	175	245	250	420	800	750	425	210	125	105
T-1	**ave**	253	330	393	508	530	860	1450	1725	883	415	228	208
T-1	**max**	445	950	1400	1450	2000	3200	3500	3050	1600	800	600	450
T-2	**min**	105	140	175	245	250	420	800	750	425	210	125	105
T-2	**ave**	253	330	393	508	530	860	1450	1725	883	415	228	208
T-2	**max**	445	950	1400	1450	2000	3200	3500	3050	1600	800	600	450
Total	**min**	**400**	**520**	**610**	**770**	**810**	**1,300**	**2,100**	**2,700**	**1,340**	**620**	**330**	**310**
Total	**ave**	**970**	**1760**	**2505**	**3035**	**3455**	**5250**	**6950**	**7150**	**3720**	**1610**	**1035**	**850**
Total	**max**	**1,540**	**3,000**	**4,400**	**5,300**	**6,100**	**9,200**	**11,800**	**11,600**	**6,100**	**2,600**	**1,740**	**1,390**

Figure 26 provides a visual comparison.

Table 9: Hypothetical quantity of water to be managed, with monthly averages per distributary. Tigris and Euphrates discharge rate (million cum

Outlet		**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**
Third River	1992	210	210	210	210	210	210
Euphrates	2002	400	400	400	400	400	400
Euphrates	1987	500	500	500	500	500	500
E-1	min	95	120	130	140	155	230
E-2	min	95	120	130	140	155	230
T-1	min	105	140	175	245	250	420
T-2	min	105	140	175	245	250	420
E-1	ave	153	200	240	315	328	535
E-2	ave	153	200	240	315	328	535
Euphrates	**min**	**190**	**240**	**260**	**280**	**310**	**460**
Tigris	**min**	**210**	**280**	**350**	**490**	**500**	**840**
T-1	ave	253	330	393	508	530	860
T-2	ave	253	330	393	508	530	860
Total	**min**	**400**	**520**	**610**	**770**	**810**	**1,300**
E-1	max	325	550	800	1,200	1,050	1,400
E-2	max	325	550	800	1,200	1,050	1,400
T-1	max	445	950	1,400	1,450	2,000	3,200
T-2	max	445	950	1,400	1,450	2,000	3,200
Euphrates	**ave**	**420**	**670**	**930**	**1,340**	**1,205**	**1,630**
Euphrates	**max**	**650**	**1,100**	**1,600**	**2,400**	**2,100**	**2,800**
Tigris	**max**	**890**	**1,900**	**2,800**	**2,900**	**4,000**	**6,400**
Tigris	**ave**	**930**	**1,830**	**2,653**	**2,968**	**3,728**	**5,825**
Total	**ave**	**970**	**1,760**	**2,505**	**3,035**	**3,455**	**5,250**
Total	**max**	**1,540**	**3,000**	**4,400**	**5,300**	**6,100**	**9,200**

Source: After Ubell 1971. See Figure 27, which visually ranks discharge rates by distributary.

Table 10: Hypothetical quantity of water to be managed, with annual totals per distributary. Tigris and Euphrates discharge rate (million cumecs), including two hypothetical distributaries each, compared to modern outlets, sorted by annual volume (cubic kilometers).

		Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**AVE**	**Annual**
E-1	min	95	120	130	140	155	230	250	600	245	100	40	50	180	5.66
E-2	min	95	120	130	140	155	230	250	600	245	100	40	50	180	5.66
T-1	min	105	140	175	245	250	420	800	750	425	210	125	105	313	9.86
T-2	min	105	140	175	245	250	420	800	750	425	210	125	105	313	9.86
Euphrates	**min**	**190**	**240**	**260**	**280**	**310**	**460**	**500**	**1,200**	**490**	**200**	**80**	**100**	**359**	**11.33**
Euphrates	2002	400	400	400	400	400	400	400	400	400	400	400	400	400	12.61
E-1	ave	153	200	240	315	328	535	925	1050	548	260	145	130	402	12.69
E-2	ave	153	200	240	315	328	535	925	1,050	548	260	145	130	402	12.69
Euphrates	1987	500	500	500	500	500	500	500	500	500	500	500	500	500	15.77
Tigris	**min**	**210**	**280**	**350**	**490**	**500**	**840**	**1,600**	**1,500**	**850**	**420**	**250**	**210**	**625**	**19.71**
T-1	ave	253	330	393	508	530	860	1,450	1,725	883	415	228	208	649	20.45
T-2	ave	253	330	393	508	530	860	1,450	1,725	883	415	228	208	649	20.45
Total T+E	min	325	550	800	1,200	1,050	1,400	2,400	2,750	1,450	500	270	245	1,078	34.01
E-1	max	325	550	800	1,200	1,050	1,400	2,400	2,750	1,450	500	270	245	1,078	34.01
Euphrates	**ave**	**420**	**670**	**930**	**1,340**	**1,205**	**1,630**	**2,650**	**3,350**	**1,695**	**600**	**310**	**295**	**1,258**	**39.67**
E-2	max	670	930	1,340	1,205	1,630	2,650	3,350	1,695	600	310	295	1,258	1,328	41.87
T-1	max	445	950	1,400	1,450	2,000	3,200	3,500	3,050	1,600	800	600	450	1,620	51.10
T-2	max	445	950	1,400	1,450	2,000	3,200	3,500	3,050	1,600	800	600	450	1,620	51.10
Euphrates	**max**	**650**	**1,100**	**1,600**	**2,400**	**2,100**	**2,800**	**4,800**	**5,500**	**2,900**	**1,000**	**540**	**490**	**2,157**	**68.01**
Tigris	**ave**	**810**	**1,430**	**2,053**	**2,718**	**2,778**	**4,025**	**5,875**	**6,325**	**3,310**	**1,305**	**788**	**670**	**2,674**	**84.32**
Total T+E	**ave**	**970**	**1,760**	**2,505**	**3,035**	**3,455**	**5,250**	**6,950**	**7,150**	**3,720**	**1,610**	**1,035**	**850**	**3,191**	**100.63**
Tigris	**max**	**890**	**1,900**	**2,800**	**2,900**	**4,000**	**6,400**	**7,000**	**6,100**	**3,200**	**1,600**	**1,200**	**900**	**3,241**	**102.20**
Total T+E	**max**	**1,540**	**3,000**	**4,400**	**5,300**	**6,100**	**9,200**	**11,800**	**11,600**	**6,100**	**2,600**	**1,740**	**1,390**	**5,398**	**170.22**

Sorted by annual volume. See Figure 27, which visually ranks discharge rates by distributary.

D. Deltaic Processes

Within the lower alluvium, two zones of geomorphologic action may be distinguished. In the Euphrates tectonic sub-zone, within a triangle bounded by Nasiriya on the Euphrates, Amara on the Tigris, and Qurna at the rivers' junction, lies a flood-prone region of channel and marsh formation, known locally as the Awhar. Within this inner delta (Figure 28), annual floodwaters mingle, spread, and slow as they encounter the Zubair sill and the strong estuarine action of tidal flushing (Buringh 1957a, 1957b, 1960; Wirth 1962; Sanlaville 1989). Until massive reclamation programs completed in

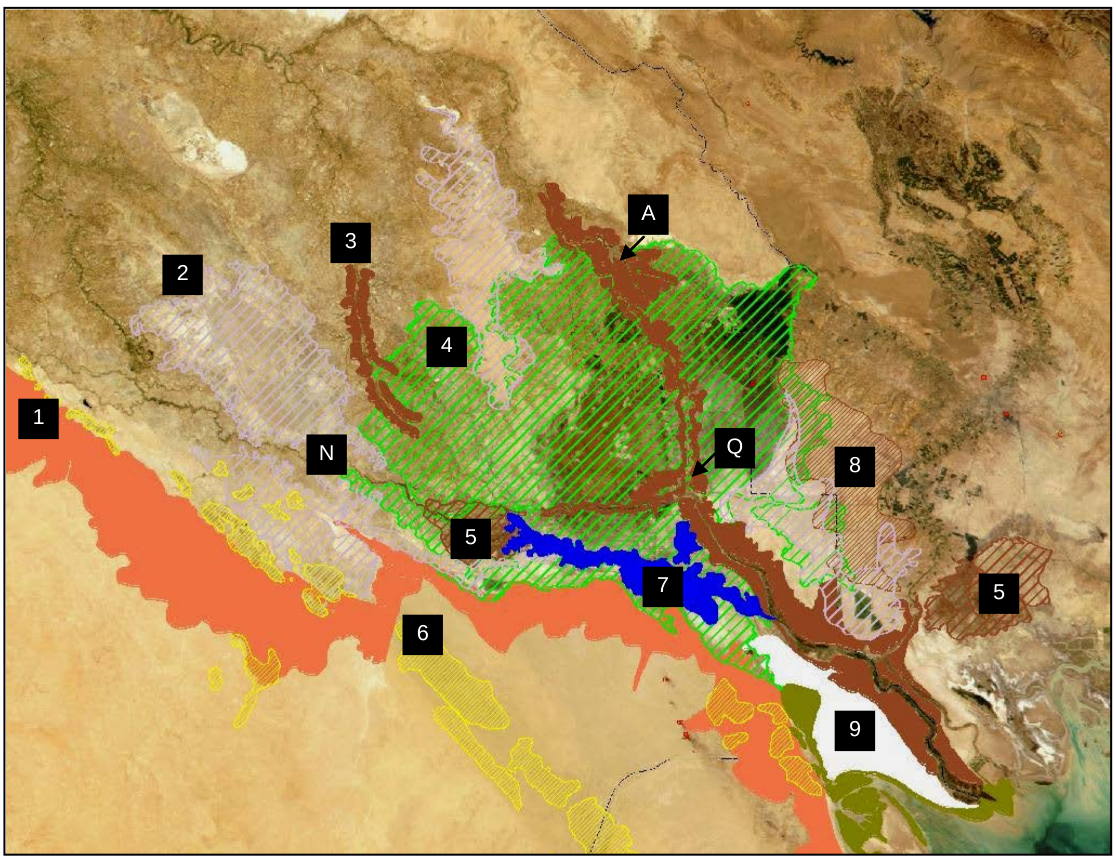

Figure 29: The Mesopotamian Delta. (1) Miocene limestone. (2) Gypsiferous soils. (3) Levees. (4) Marshes (Awhar). (5) Crevasse splays. (6) Dunes. (7) Lakes (perennial) (8) Alluvial sediment. (9) Sabkha (Salt panne). (N) Nasiriya. (A) Amara. (Q) Qurna.

2001 drained the joint Tigris-Euphrates outflow directly into Gulf waters, the Awhar was within historical times a domain where permanent and seasonal lakes and marshes prevailed (Brasington 2003, NASA 2000, 2001a; Partow 2001; Kouchoukos 1998; Sanlaville 1996). In 1946, before completion of water impoundment schemes, up to 90% of Tigris flows at Kut passed into the marshes before reaching Amara (Buringh 1957b: 34). By 1997 only one-third to one-quarter of the Euphrates flow into the alluvium even reached Lake Hammar, with none remaining to contribute to Shatt al-Arab outflows, which now derive almost entirely from the Karun (Table 11).

Table 11: Water entering Iraq as of 1997 (cubic kilometers per year)*

	TO: IRAQ MIN	MED	MAX	REMAINDER	TO:
Euphrates	10.00	30.00	40.00	10.00	Hammar
Misc.		1.00			
Greater Zab		13.20			
Lesser Zab		5.07			
Adhaim		0.79			
Diyala		5.74			
Tigris		21.20			
Tigris Subtotal:		47.00		2	Shatt al Arab
Karkheh		6.30		6.30	Al Hawizeh
Karun		24.70		24.70	
Total:		108.00		26.70	Shatt al Arab

*Source: Larsen 1975; FAO 1997; Naff and Hanna 2003.

Across the Zubair sill, within the Basrah tectonic sub-zone, the Shatt al-Arab estuary builds an outer delta where Karun river sediments dump into the Gulf (Figure 29). Its outflow constrained to the west by the Wadi Batin fluvial cone, and to the east by the Karkheh–Karun alluvial fan emanating from the Zagros mountains, the Shatt al-Arab builds a littoral zone transitioning from (1) fresh water marshes at the Tigris-

Euphrates confluence at Qurna, through (2) brackish channels south of Basrah and the Karun confluence at Abadan, to (3) permanent salt marshes at the Persian Gulf head. Diurnal tides twice daily push Gulf waters up the estuary, raising mean sea levels in shipping lanes by up to two meters. This tidal action also checks freshwater outflow, similarly raising estuarine fresh water levels ahead of the tidal surge. Palm groves situated in low-lying ground along the Shatt were thus irrigated and drained with no need for intervention beyond occasional clearing of drainage ditches between the stands (Wirth 1962: 150–151, fig. 34). The region subject to this tidal flushing is thus directly influenced by variations in mean sea level and Gulf Head progradation.

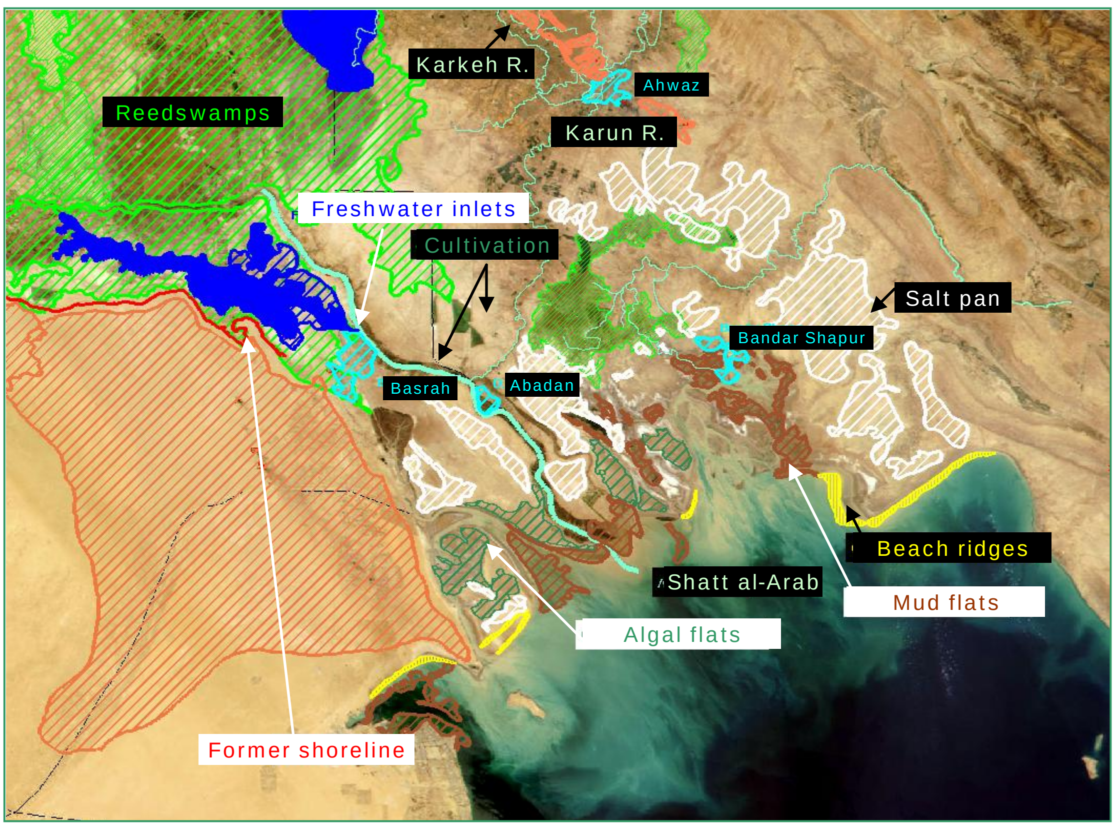

Figure 30: Outer (marine) delta, characterized by fine-grained sediment and algal flats, mud flats and sand bars, relict beach ridges, sabkha (salt panne), riverbank cultivated zones, and freshwater inlets from marshes and lakes.

A mid-Holocene marine incursion, extending gradually northward through the deltaic cone during the sixth to fourth millennia BCE and subsequently receding,[53] at its maximum pushed the brackish estuary zone inland, and further slowed outflow already constrained by the Wadi Batin and Karun-Karkheh fans. Recent work by Lambeck (1996), Sanlaville (1996, 2003), and Aqrawi (1997, 2001) reinforces the conclusion that by the early fourth millennia BCE marine transgression extended as far inland as Nasiriya and Amara, reaching a maximum level at least one or two meters above present (Figure 30). Thereafter, between the early third and first millennia BCE, with some intermediate oscillations, the Gulf head had again retreated to near its present location. There have been several additional variations since.

On the margins of this region, relict landscapes are photographically revealed especially clearly following the spring floods that saturate soils, replenish groundwater (Buringh 1957: 35), and temporarily cover tracts of what is now desert with sheets of water that until the early 1990s drained through the Awhar and into the Shatt al-Arab estuary. CORONA photographs, imaged before massive irrigation, drainage, and water diversion projects brought an end to millennia-old marsh formation processes, allow us to compare the geomorphology of the active lower Tigris–Euphrates delta to that of the now-desertic urban heartland. The more comprehensive photographic record may also be referenced to the limited, but not insubstantial, archaeological

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[53] See Potts (1997: 31–42, 47–55) and Kouchoukos (1998: 216–231) for critical summaries of relevant geomorphologic and paleoclimatic analyses, based upon Sanlaville 1989 and el-Moslimany 1994.

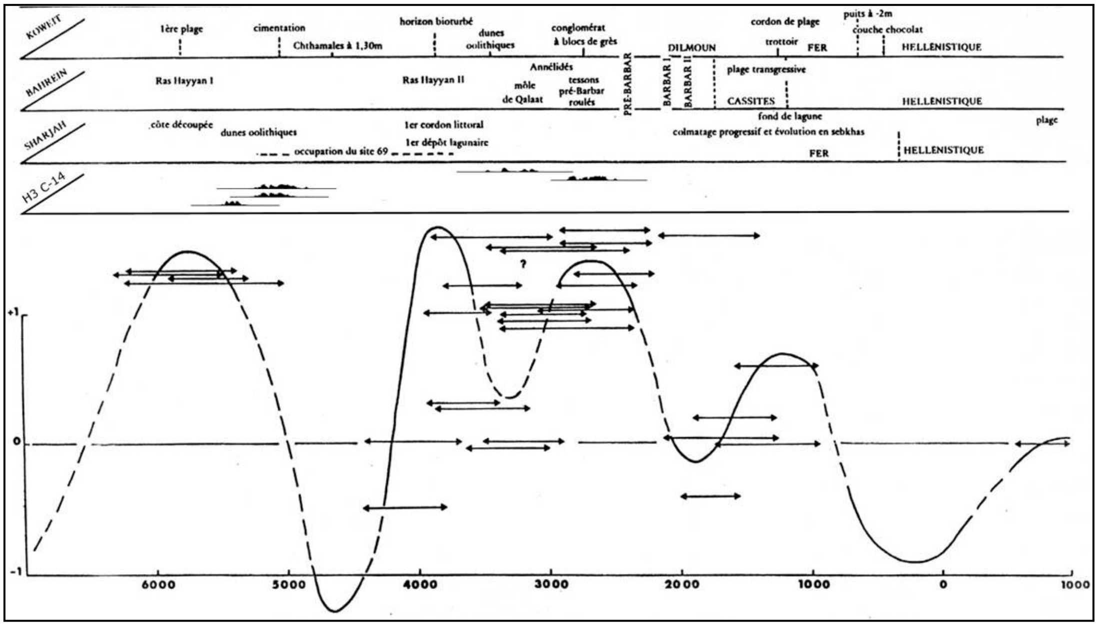

Figure 31: Synthetic curve of sea level variations in the Gulf. Source: Carter personal communication 2003, after Dalongeville and Sanlaville 1987. Used by permission.

record. That ground evidence includes artifacts, botanical and faunal remains, stratigraphic profiles, and other geomorphologic data suggesting that conditions similar to those obtaining in the twentieth-century Tigris-Euphrates marshlands could have extended during the mid-Holocene across then-extant river distributaries, into the Warka, Eridu, and East Gharraf survey areas (Geyer and Sanlaville 1996; Sanlaville 1996: 96; Aqrawi 1997).

Recent re-examinations of sediment cores originally collected in the 1970s provide the basis for assessing the extent and boundaries of the Gulf transgression and its impact on the deltaic system. To clarify assessments of the extent and timing of marine incursion inferred from eustatic fluctuation (Sanlaville 1989), stratigraphy profiled in boreholes from Nahr Umr 2, Qurmat Ali, Bandar Mashur, and Fao (Larsen 1975) can be compared to archaeological evidence and dated sediments from boreholes A–H drilled 1979–1980 by the Survey of Iraq (Aqrawi 2001:271) (Figure 31). Aqrawi (1995) followed earlier radiometric dating of sediments (al-Zamel 1985, Godwin, Surggate, and Wills 1958) with formal studies of sediment deposition and compaction rates, settling conjectural disputes regarding the relative contributions of tectonic uplift, tectonic subsidence, sediment deposition, and deltaic compaction in determining Holocene shorelines. His work reinforced arguments that the primary influence on deltaic evolution in lower Mesopotamia was eustatic fluctuation, that mid-Holocene marine transgression as far inland as Nasiriya–Amara was followed by sedimentation and progradation to or beyond the present shore, and that marine influx could not be correlated to tectonic activity (al-Azzawi 1986; Sanlaville 1989).

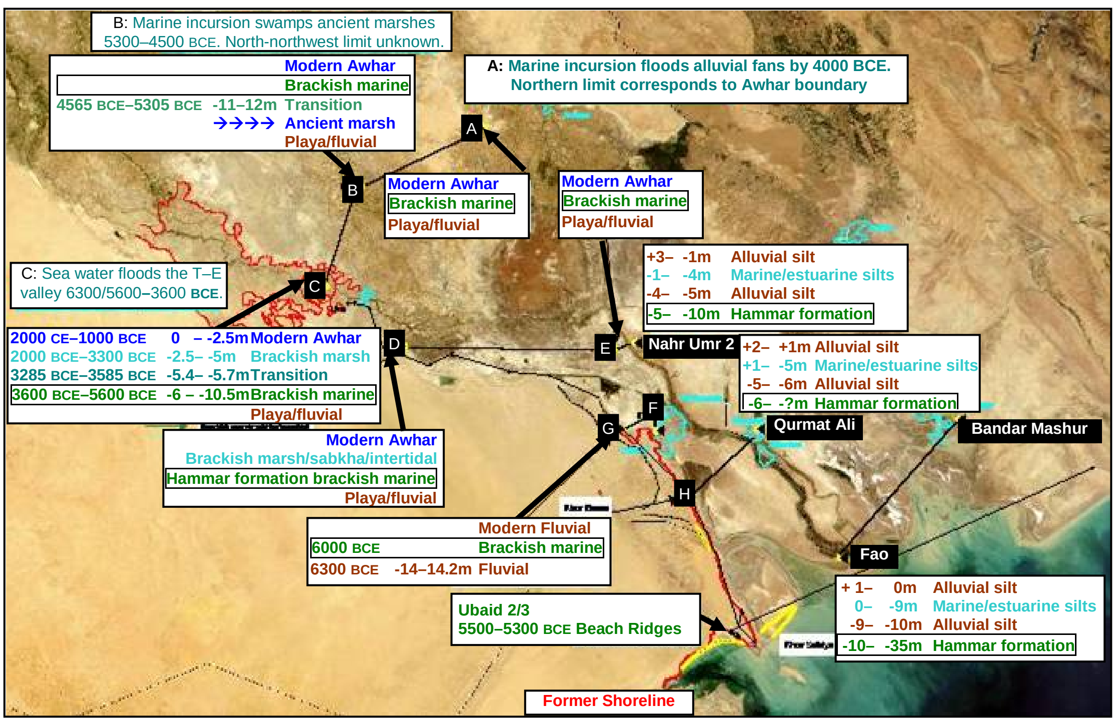

Figure 32: Stratigraphy profiled in borehole cores from Nahr Umr 2, Qurmat Ali, Bandar Mashur, and Fao (Larsen 1975) can be compared to archaeological evidence and dated sediments from borehole cores A-H (Aqrawi 2001).

In 2001 Aqrawi followed this study with additional radiometric dating and detailed examination of sediment micromorphology in cores taken from boreholes A–H, providing new evidence regarding the effects of both eustatic fluctuation and climatic change. He found that during the early Holocene (pre-transgression), lower Mesopotamia was covered with organic-rich ancient marsh or lacustrine silty sands, merging into the thicker ancient fluvial plain deposits (alluvial fans) in the east, and into clay-sand-silt playas along the western margins. These playas were characterized by high gypsum, dolomite, and palygorskite, indicating arid climate.

Marine transgression progressed during the middle Holocene (Figure 32), indicated by grey clayey brackish–marine silts rich in foraminifera (*Ammonia beccarri*) and ostracods (*Cypridis torosa*), equivalent to sediments of the so-called Hammar formation (Larsen 1975). From the latitude of Fao–Abadan at about 7000 BCE (then 35 meters below the present surface), deposition of these sediments proceeded northward to Basra–Zubair (F–G) by about 6000 BCE (then about 10 meters lower than today), reaching Amara about two millennia later (also about 10 meters lower than today). Sediment composition and organic content indicates fresh–salt water mixing at the western margins, and wetter climate. Knowing the extent of these marine deposits, while allowing for the known constraints of the Wadi Batin cone, Zubair sill, and Karun delta, while allowing for *both* lower surface levels for the alluvial floor, and lower sea levels for the encroaching water, we can roughly plot shoreline contours at approximately 6000 BCE (Figure 33).

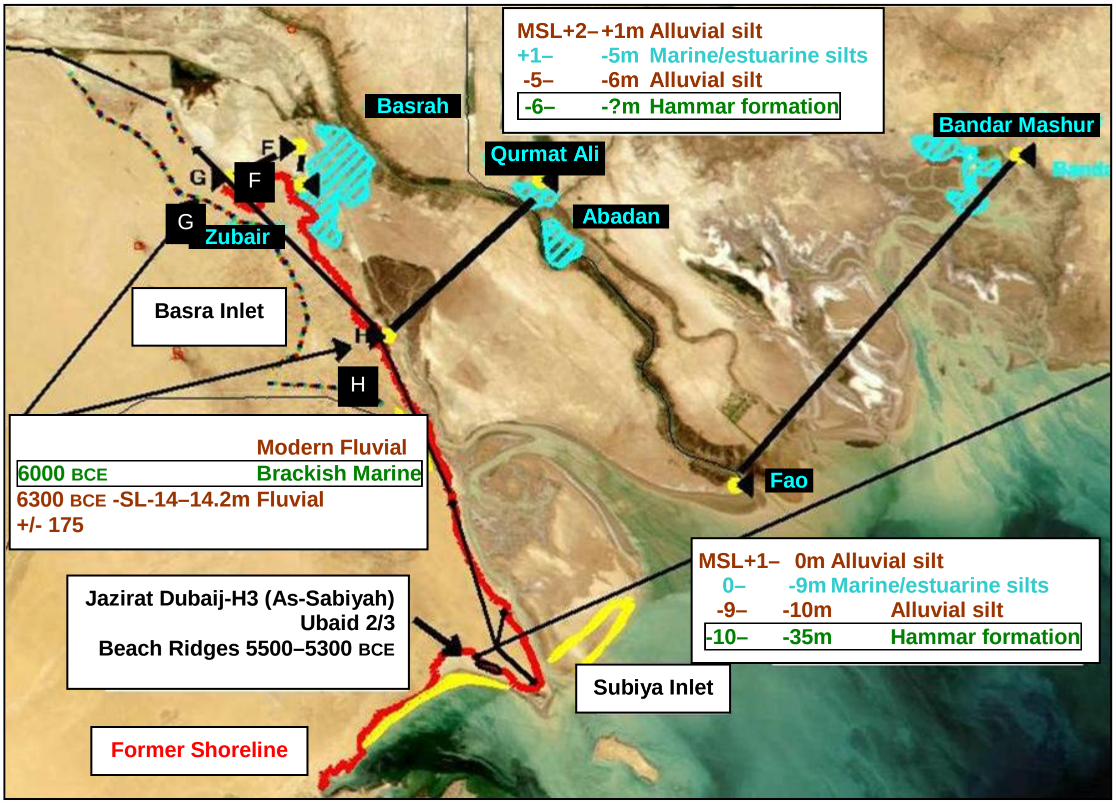

Figure 33: Core Series: F-H. Former shoreline in red. Depths of strata indicating Holocene transgression (Brackish marine/Hammar formation) after Aqrawi 2001 (lettered), with MSL as datum by Larsen 1976 (Basrah, Qurmat Ali, Fao).

Figure 34: Marine incursion at 6000 BC

While imagery can do little to clarify the rate of the continuing incursion, it can help clarify its extent. As rising Gulf waters approached the Zubair sill, they scoured the pebbly colluvium of the Wadi Batin cone, demarcating their passage with beach ridges left along old shorelines (Figure 34–Figure 39). At Qurmat Ali, marine sediments, the bottom of which were dated from cores F–H to ~6000 BCE, extend to one meter above present sea level, indicating that past sea level must have been somewhat higher than that. How much higher, and at what dates, is the question.

Calibrated radiocarbon dates from shell collected during excavations at a small ‘Ubaid 2/3 settlement (designated H3) on the Kuwaiti coast northwest of Falaika Island, date the southernmost of these ridges to circa 5500–5300 BCE (Figure 34,

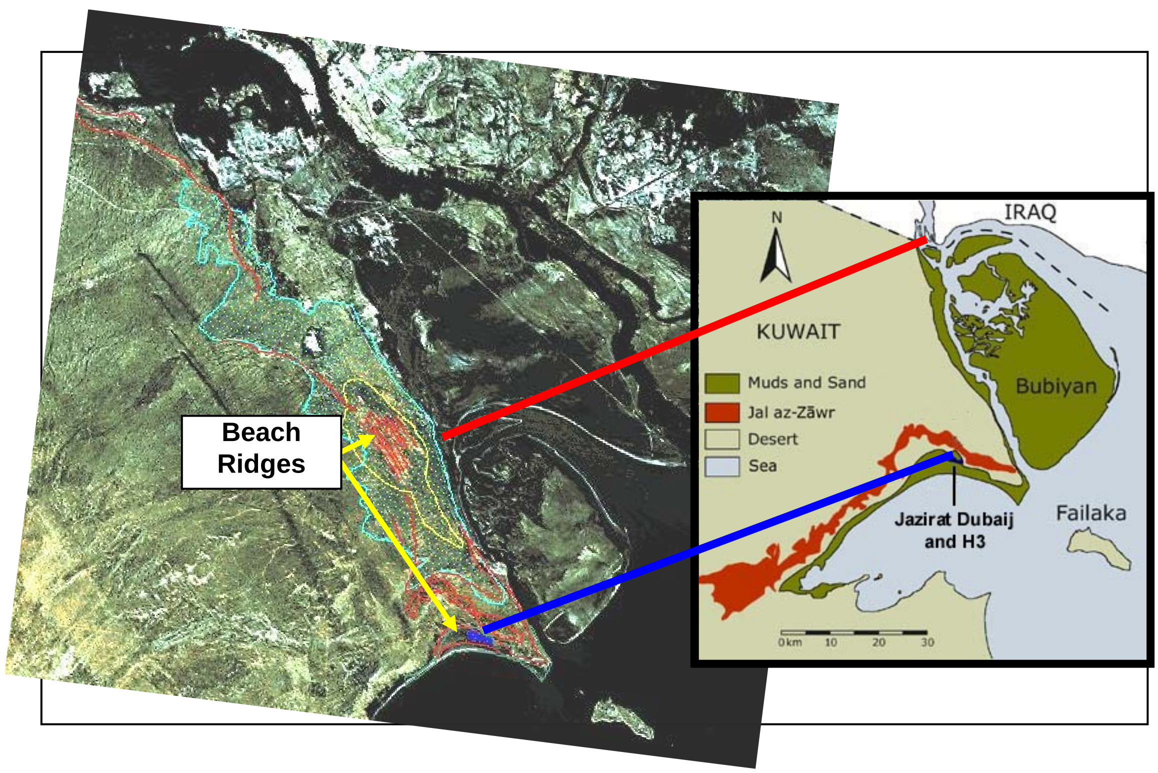

Figure 35: Subiya Inlet with Jazirat Dubaij. LANDSAT image (2653-06291 30 December 1980), showing beach ridges along the Kuwaiti coast and Subiya Inlet (Coleman, Roberts, and Huh 1986). Inset: Carter and Crawford 2001.

Figure 36) (Carter and Crawford 2001). Those ridges may be associated in two ways with ridges further inland, along the Basrah Inlet, in order to reconstruct portions of the western shoreline at the time of sea level maximums (Figure 35). Archaeologically, it is known that from its inception H3 bordered the sea. Faunal analysts recovered bones of great crested grebe, shallow-water marine fish, catfish, marine and intertidal shell, and a small number of freshwater mussel shells (*Unio tigridis*) characteristic of Tigris and Shatt al-Arab marshes. Mammalian fauna included gazelle, domesticated sheep/goat and cattle, but not pig. The presence of boat remains and other boat-related artifacts demonstrate that pottery was being moved between ‘Ubaid Mesopotamia and Neolithic Arabia on bitumen-coated reed-bundle watercraft. The bitumen, of Kuwaiti source, is tempered with chopped reed. *Balanus trigonus* barnacles found on the bitumen cladding typically occur in creeks, sheltered harbors, and estuaries (Carter, personal communication 2003). This evidence strongly

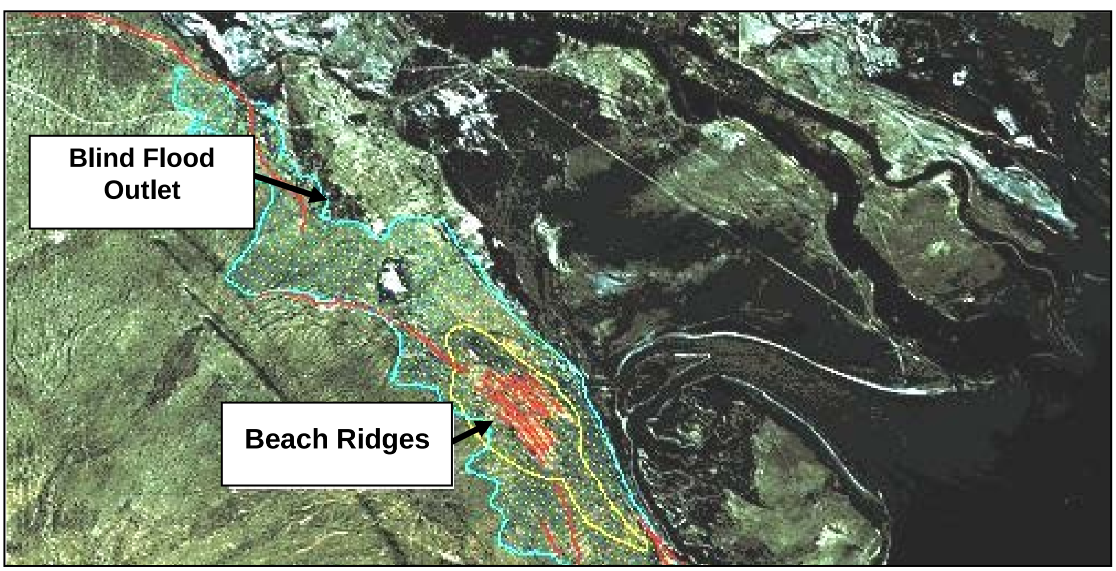

Figure 36: Subiya Inlet Beach Ridges. Close-up of ridges straddling Iraq-Kuwait border. Note blind flood outlet—compare to Figure 37.

suggests a marine littoral setting (at the site) in near proximity to a freshwater estuary (frequented by the boats). Remembering that the surface of the lower delta in the vicinity of Fao was during the mid-sixth millennium BCE on the order of ten meters below the surface today (and submerged), and that the general trend for admixture of fresh and marine sediments was to the west (Aqrawi 2001), it is possible that a southeast-trending down-cut into the fluvial cone represents a contemporary estuarine scour channel or blind flood outlet (Figure 35).

Spectrally, this proposition can be tested by examining multispectral imagery for characteristic reflectance signatures. MODIS Bands 1–3 are sensitive to surface reflectivity, and may be rendered as true-color images by assigning each color values of red, blue, and green, on a scale of 0 (=absolute absorption) to 255 (=absolute reflectance) (Figure 36).[54] By mapping spectral contours that mark like reflectance values for each Band, narrow reflectance distinctions can be demarcated that are difficult or impossible to discern by visual examination of color, hue, and tone. The beach ridges adjacent to H3 have a characteristic signature that falls within a narrow range of values at the border between two spectral contours (yellow and cyan lines).[55] This same signature characterizes the ridges south of the Basra Inlet on the Kuwait-

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[54] True-color MODIS surface reflectance, rendered as minimum blue RGB: Red=Band 1, green=Band 2, blue=Band 3, created by Nazmi El Saleous at the NASA MODIS land surface reflectance science computing facility, <http://modis-land.gsfc.nasa.gov/mod09/>. See note 55.

[55] Spectral contours applied to Band 3 (blue 0–255) in RSI ENVI™ 3.5, yellow: 106, cyan: 146. This range generally corresponded to a Band 2 (green 0–255) contour of 182, but was more sensitive to variations of interest in the area depicted at Figure 35. I have not yet examined higher-resolution imagery that might show this more clearly.

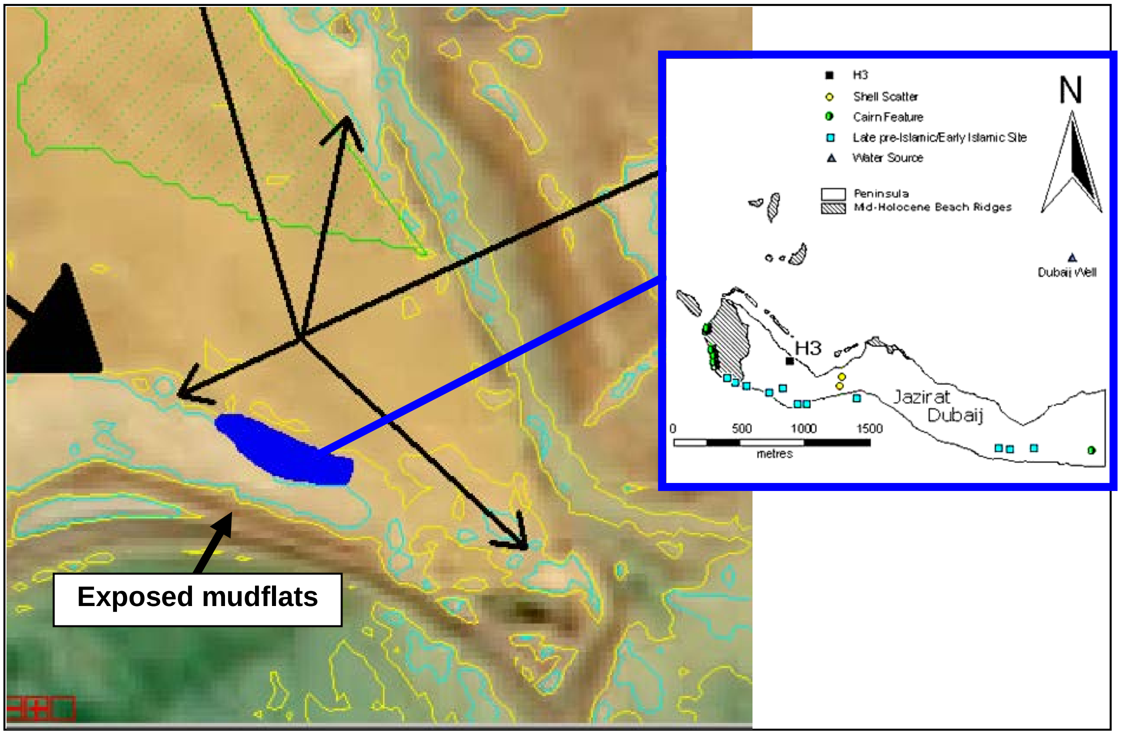

Figure 37: Jazirat Dubaij and H3. Image: MODIS (NASA 2001b), with spectral contours indicating exposure of H3 strata. Inset: Carter and Crawford 2001.

Iraq border, suggesting erosion to equivalent strata.

The scour channel (blind flood outlet) associated with the beach ridges above Basrah inlet clearly is not recent. Three-dimensional rendering shows it to be severed from the Wadi Batin north of the Iraq border, but its crest to be two or three meters higher than even the largest relict river levee (Figure 37). By rotating this image, it becomes clear that it terminates at the beach ridges arrayed perpendicular to the Iraq–Kuwait border (Figure 38). The dark strata corresponding to mud flats just above present-day sea level are clearly defined, providing an index against which local sea level rise above that of today may be demarcated. It is tempting to conclude that the ridges were therefore created by tidal flushing that cut into the Wadi Batin cone, although we cannot yet rule out the possibility that they are dunes aligned with

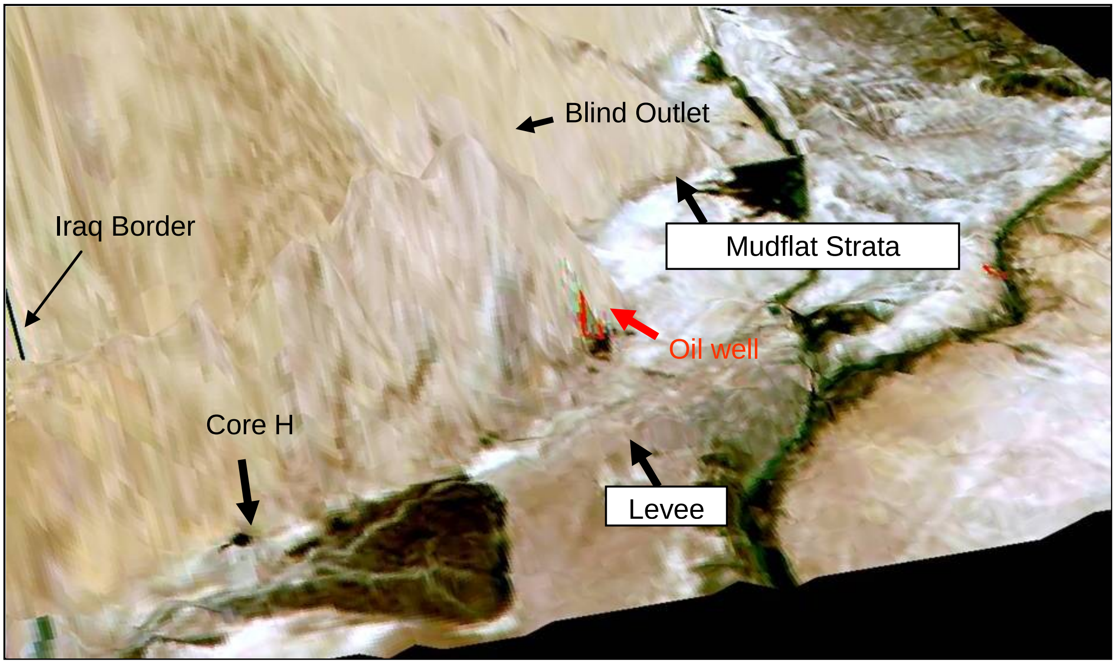

Figure 38: 3D-rendering of Basra Inlet. The alluvial fan of the Wadi Batin is clearly separated from a remnant “ridge” by what was possibly a drowned outlet. MODIS image drape over 35m DEM with 1800X vertical exaggeration.

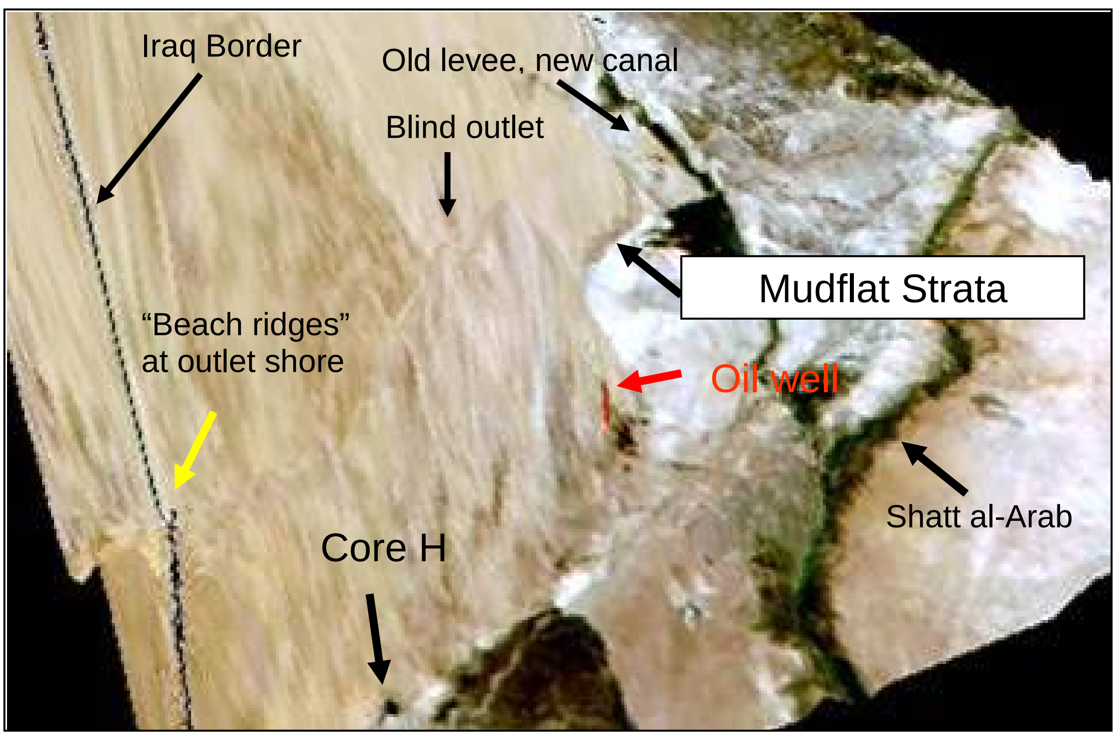

Figure 39: The outlet shore near the Iraq–Kuwait border corresponds with beach ridges at Figure 34. Note Core H extraction site, and the elevation of mudflats.

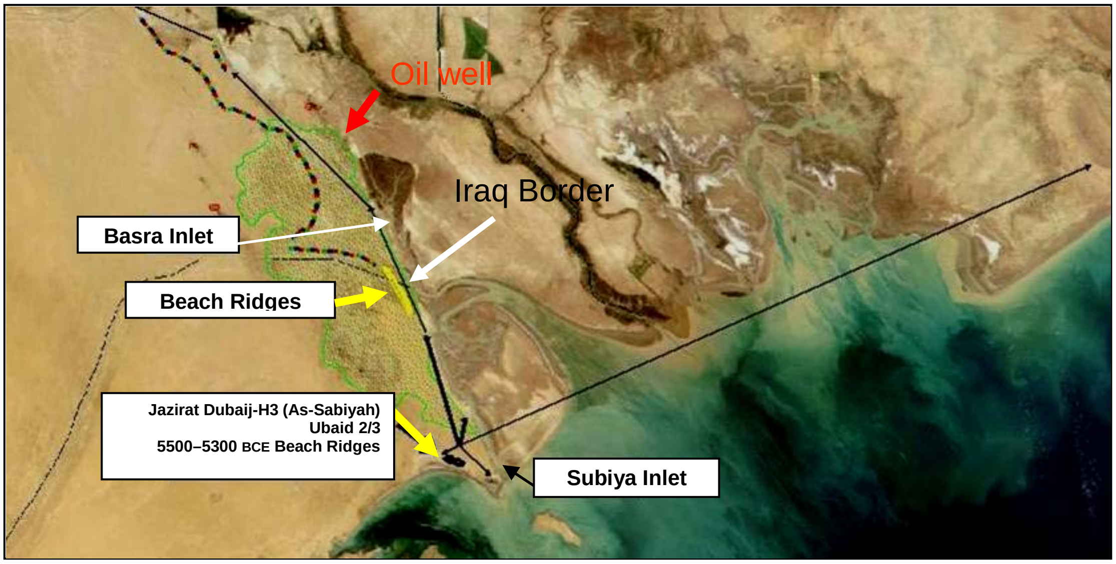

Figure 40: Gulf Head, showing strata exposed at the mid-sixth millennium BCE (black arrows), based on H3 dates (Carter and Crawford 2001) and spectral matches. Oil well head (red arrow) noted for reference.

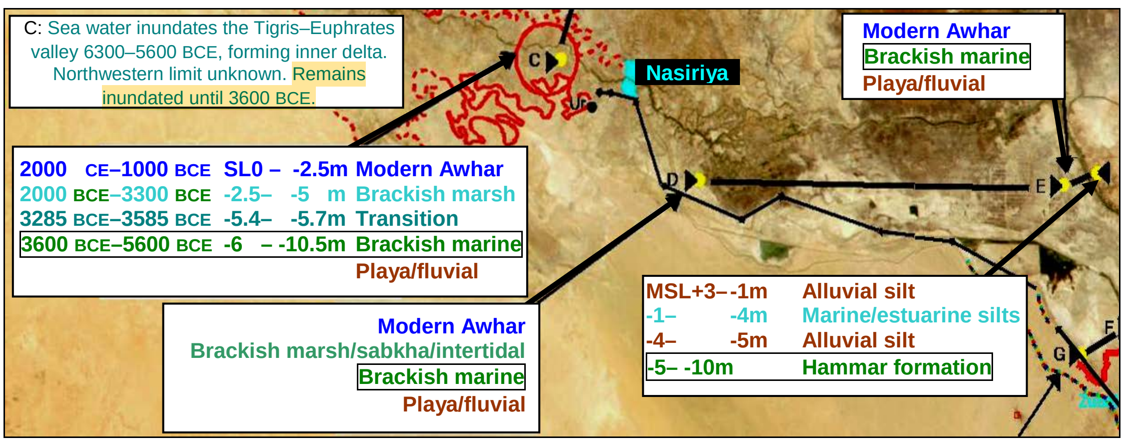

Figure 41: Core Series: C-E. Note Brackish-marine (transgressive) sediments, dated at core C to ~5600–3600 BCE, at 6–10.5 meters below the present surface.

prevailing winds. Nevertheless, this line can be matched spectrally to beach ridges east of the Musa Inlet and Bandar Mashur in Iran, and traced visually around the extent of the Batin fan (Figure 39, continued at Figure 40).

The brackish marine sediments of the Hammar formation began to be deposited at borehole C, just northwest of Ur, circa 5600 BCE. Therefore, at least as far inland as core C, at 5600 BCE, the surface of the present Euphrates valley, 10.5m lower than present, was drowned by sea water. According to 1991 Soviet topographic maps, benchmark elevations in the Ur–Eridu basin range from Mean Sea Level (MSL) +8m on the Euphrates levee, to MSL+5m on the Euphrates back slope. It is unlikely that the borehole would have been made through the extra depth of the levee, so the depths of these deposits (6–10.5 meters below the present surface) would roughly correspond to the range present MSL+1m–MSL-5.5m. Water at the time must have been sufficiently deep to lay undisturbed deposits without alluvial admixture—by comparison to present-day Mesopotamian shelf, on the order of 10m (Uchupi, Swift, and Ross 1996). This suggests that current sea level estimates of +1–2m for the period (6700–3700 BCE) may be too low (Lambeck 1996), and that local mean sea level at 5600 BCE could have been as much as +4.5m.[56] If the H3 beach ridges and those at the Iraq-Kuwait border can be correlated to the blind outlet shown at Figure 37 and Figure 38, H3 would appear to be situated one meter above extreme high tide for a local MSL at 5600 BCE of present MSL+4.5m.

Supporting this conjecture is the geomorphology of Lake Hammar, which appears to be a marine scour basin infilled subsequent to the transgression (discussed below). In summary, it would appear that between 6000 and 5600 BCE the Gulf flooded into the river valley, creating a narrow tidal estuary (Figure 41). This interpretation is supported by findings from borehole B (Figure 42). At cores C–G,

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[56] [Present MSL]-[5.5m] (level of the base of the brackish-marine deposit)+[10m] (minimum depth of water needed to precipitate undisturbed deposit)=[present MSL+4.5m].

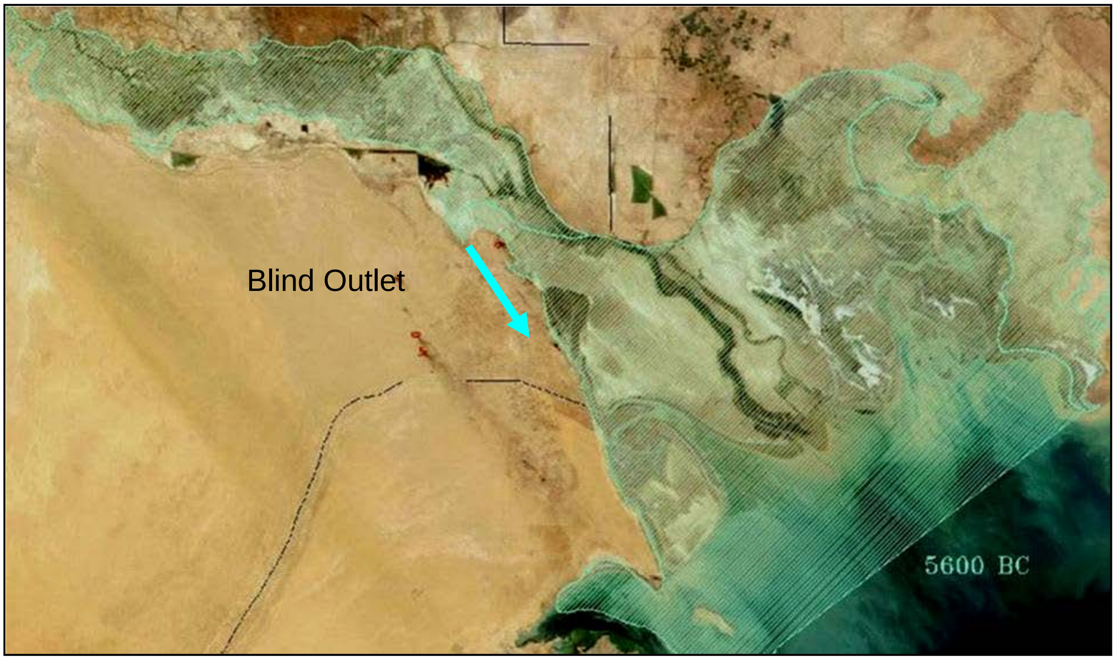

Figure 42: Marine incursion, 5600 BC

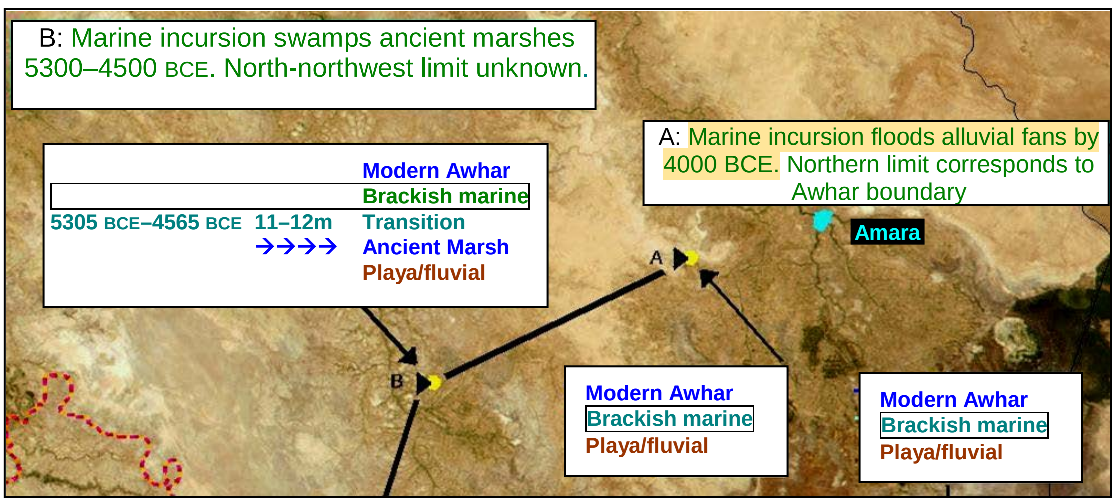

Figure 43: Core Series: B–A. Data source: Aqrawi 2001.

where alluvial playa and fluvial sediments underlie the Hammar brackish marine deposits, just south of archaic Tello, spread an ancient marsh. It appears to have remained intact for several centuries. Thereafter, for nearly a millennium, it became a transitional zone, its sediments worked and reworked until they were finally inundated

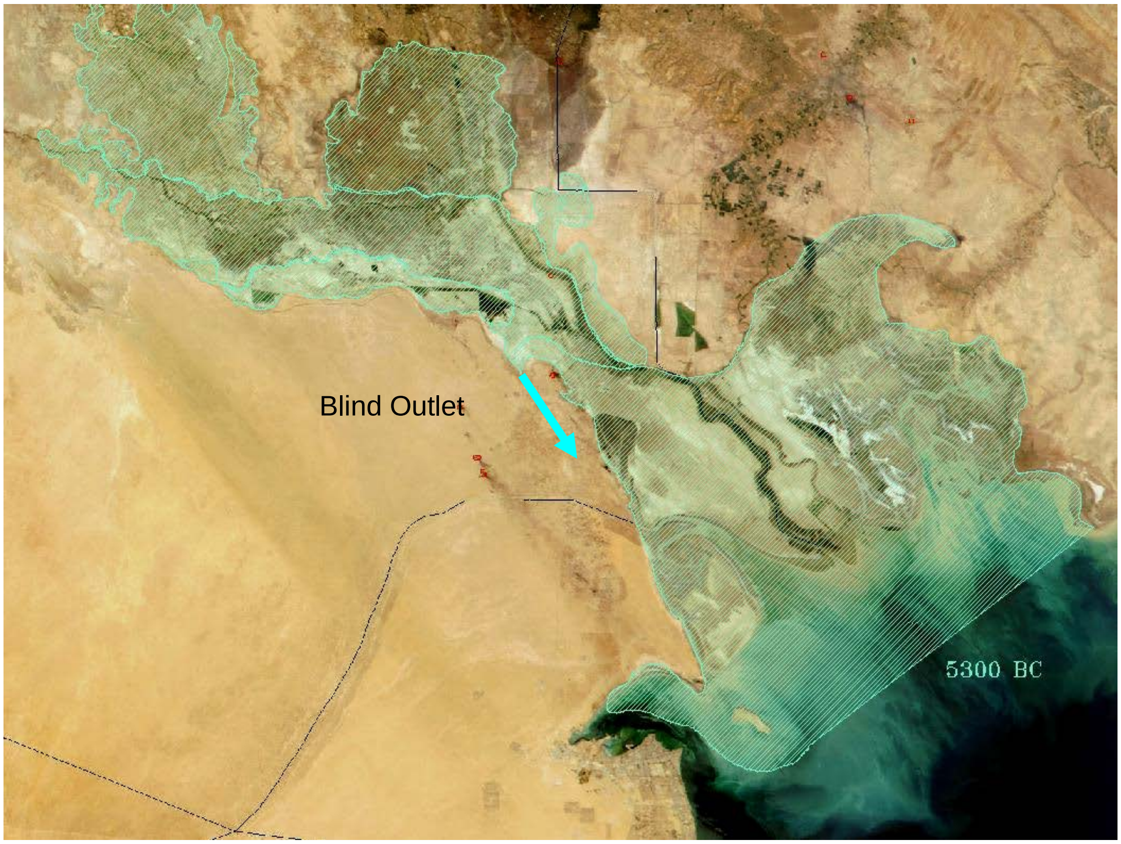

Figure 44: Marine Incursion, 5300–4550 BCE.

around 4565 BCE (Figure 43). Apparently, the inflow of rising sea levels was for some time countered by Tigris–Euphrates outflows there.

That the conjoined Karun-Karkeh alluvial fans constrained inundation to the north and east is shown at borehole A, taken near Amara. Not until the end of the ‘Ubaid period, when sea levels reached their maximum at around 4000 BCE (cal) did brackish marine deposits begin to accumulate atop the alluvial sediments. Indeed, the subsequent sediment archive indicates that the Awhar formed by infilling the scour basin left by marine regression. Thus, by mapping the boundaries of the Awhar (Figure 44), we may approximate the boundary of the marine transgression at its maximum extent. Bearing in mind that, like the current outer delta, what probably

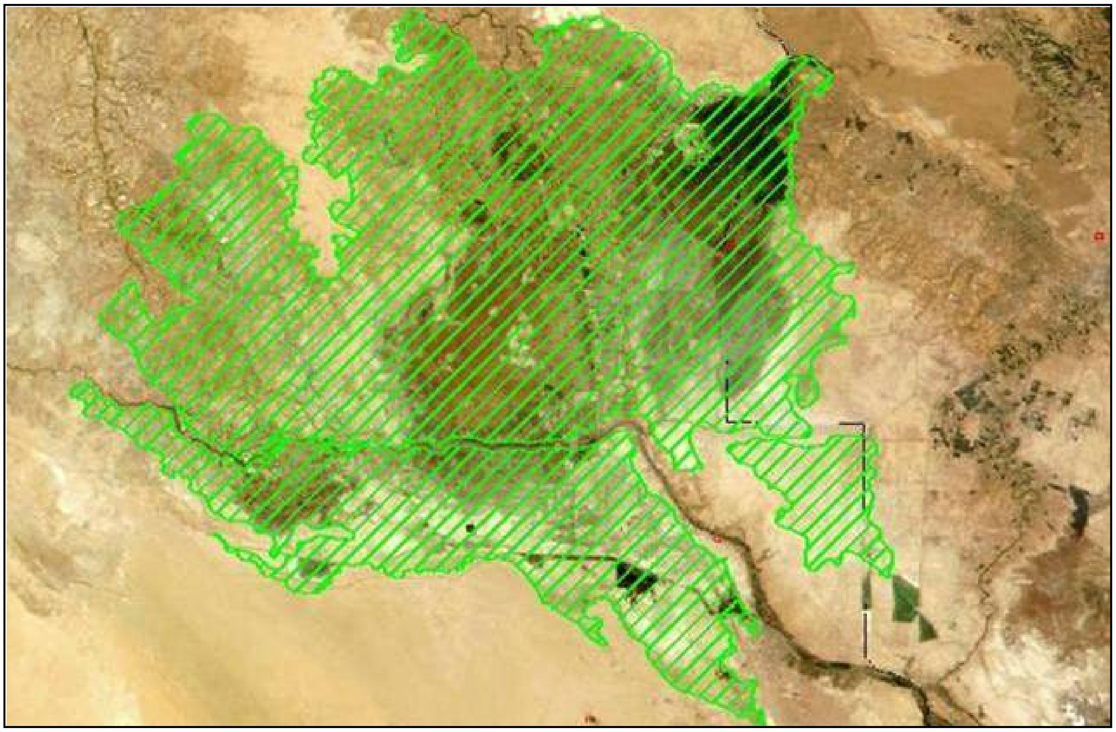

Figure 45: Marsh and lake zone (Awhar): a scour basin north of the Zubair sill.

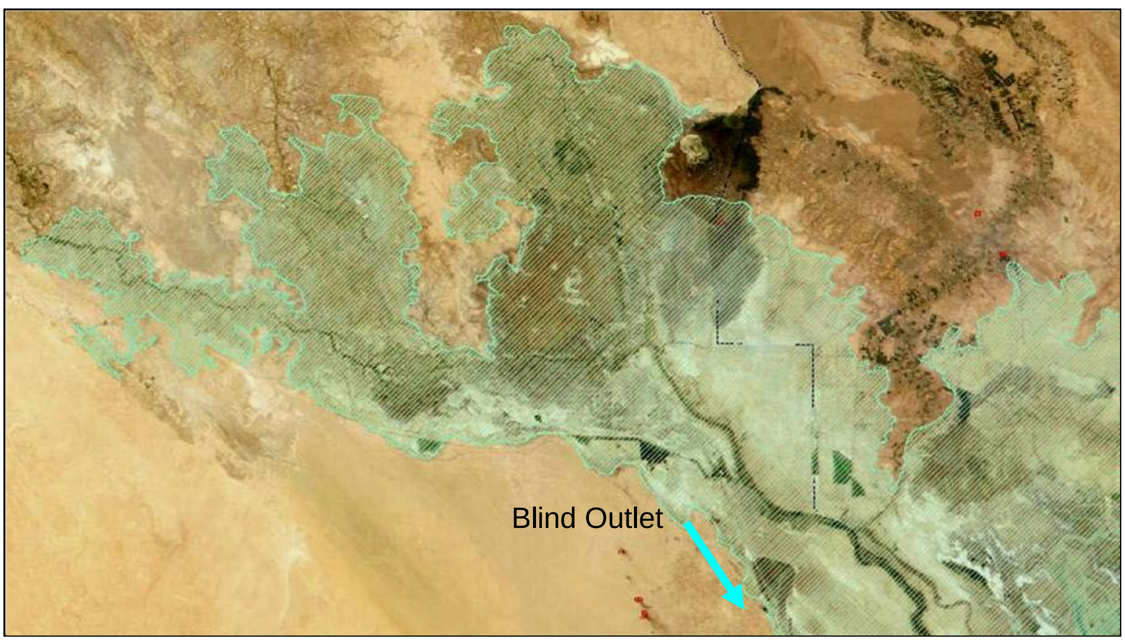

Figure 46: Marine incursion, 4000–3300 BCE.

formed was a checkerboard of fine-grained sediment and algal flats, mud flats, sand bars, beach ridges, salt panne(sabkha), cultivated riverbanks, and freshwater inlets, and that especially to the west we have neither corings nor relict shorelines to indicate the extent of marine encroachment, based on these boundaries and spot elevations we may nonetheless conservatively map the boundary zone as shown in Figure 45. The presence of estuarine and marine gastropods, lamellibranches, and foraminifers indicate that the area south of Amara remained inundated through the third millennium BCE (Sanlaville 2003:141–42, citing Purser et al. 1982; al-Azzawi 1986). Brackish marine sediments also persisted near Nasiriya (borehole C, Figure 40) until 3600 BCE. Thence, over several centuries the area remained a transitional zone, until becoming a brackish coastal marsh or intertidal sedimentary bed around 3300 BCE, indicating the onset of marine regression. It remained generally so until the early second millennium BCE, although between 3500–3000 BCE (Mid/Late Uruk–Jemdet Nasr) storm-deposited dune-sand layers of 0.5 cm are preserved in boreholes C and D, and by 3000 BCE, gypsum, evaporitic dolomite and palygorskite indicate the formation of supratidal flats (sabkha) under an aridifying climate (Aqrawi 2001).

By 2000 BCE, highly salinized soils developed; aeolian deposition increased, and sediment load deposition decreased to less than 0.5 m per millennium, while the fresh–salt mixing zone generally moved east (Aqrawi 2001). However, only 30 kilometers northwest of core C (near Figure 25, 11) in the Larsa–Oueili area (Figure 25, 10), examination of approximately 80 sediment samples and stratigraphic profiles taken from excavations, wells, and drainage cuts showed light silty deposits rich in fresh water mollusks characteristic of lower Tigris marshes,[57] carbon dated at 1577–

[57] *Bellamya bengalensis, Melanoides tuberculata*, and *Lymnaea auricularia.*

941 and 673–21 BCE (Geyer and Sanlaville 1996), showing the importance of localized studies in landscape reconstruction.[58] Contemporaneously, shelly beach ridges on the south shore of Bubiyan island, dated 1500–800 BCE (see Figure 32, Figure 34), suggest deltaic progradation to its current shore (al-Zamel 1985).

From 1000 BCE, starting in the north (core A), brackish- marine deposition terminated, and deposition of fluvial plain muds began, indicating progradation of the river delta. Within the Awhar, where Aqrawi examined 16 short cores plus 5 sediment samples from recently dug drainage channels, fluvial sediments extend only to depths of between one and 2.5 meters (Aqrawi 1995). There, the clayey brackish-marine silts upgrade rapidly to lacustrine shelly deposits, as the basins scoured by marine incursion began to fill with permanent lakes (Aqrawi 2001: 271, Buringh 1960: 185) (Figure 46). While marshy Awhar deposits generally accumulated continually thereafter, the large open body known as Lake Hammar is thought to have formed in the seventh century CE when the Tigris, flooding down the Shatt al Gharraf, overtopped the Euphrates' banks (Le Strange 1905). Dark clayey-silty sediments from the Larsa-Oueili area, carbon dated between 975–1445 CE, characterized by abundant

[58] From the fourth millennium onwards, local dating of deposits is especially crucial, as deposition depths become unreliable for correlating strata due to variable tectonics that effect disparities of 1–3m between Falaika Island (Kuwait) and Bahrain/United Arab Emirates that cannot be correlated with eustatic change (Bernier, Dalongeville, Dupuis, and Medwecki 1995). The western border of the unstable Mesopotamian shelf especially is subject to localized up- and down-warping. For example, the western shore of the Abu Dibbis lake depression is now higher than its own eastern shore—a shift that has occurred since the late Paleolithic (Voûte 1957: 144).

fresh water mollusks[59] are thought to be of this era (Sanlaville 2003: 144). Organic preservation decreases markedly with increasing salinity, varying from 22% to 1% of sediment content, but the relatively recent origin of the Hammar lake bed, covered generally with 5–10 cm of organic-rich sand and silt preserved by anoxic conditions, is clear. The existing Shatt al-Arab also formed only during the first millennium CE, following an old Tigris channel (Aqrawi 2001).

As should now be apparent, the nineteenth and twentieth century wetland zones of southern Iraq were a combination (Figure 47) of alluvial boundary wetlands

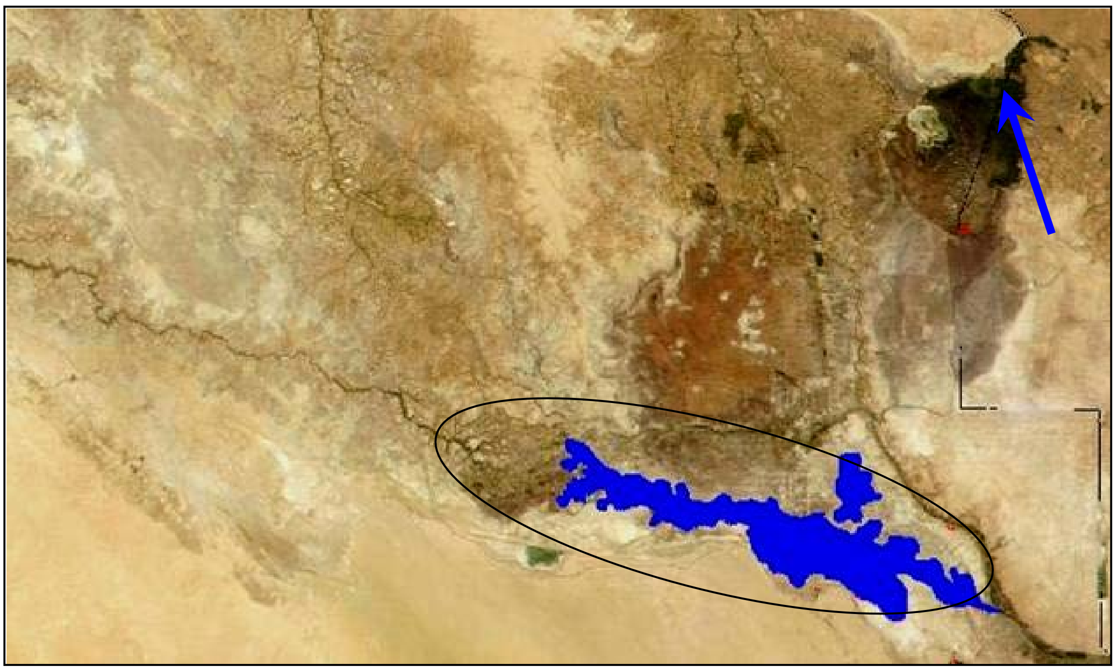

Figure 47: Lakes. Lake Hammar (circled) gradually infilled the scour basin left by regressing Gulf waters after 2000 BCE (Aqrawi 2001). Flooded with fresh water when the Euphrates burst its banks around 600 CE, it formed the core of lower Euphrates marshes and outlets to the Gulf (DeMorgan 1900, LeStrange 1905, Lees and Falcon 1952), but was completely drained by 1997 (Partow 2001, Brasington 2003). Lake al-Azim (arrow) has been reduced to a marshy remnant by related programs. The dark patches between these markers comprise the desiccated marsh-lake basin.

[59] Including *M. tuberculata*, *L. auricularia*, *Corbicula fluminalis*, and *Unio tigridis.*

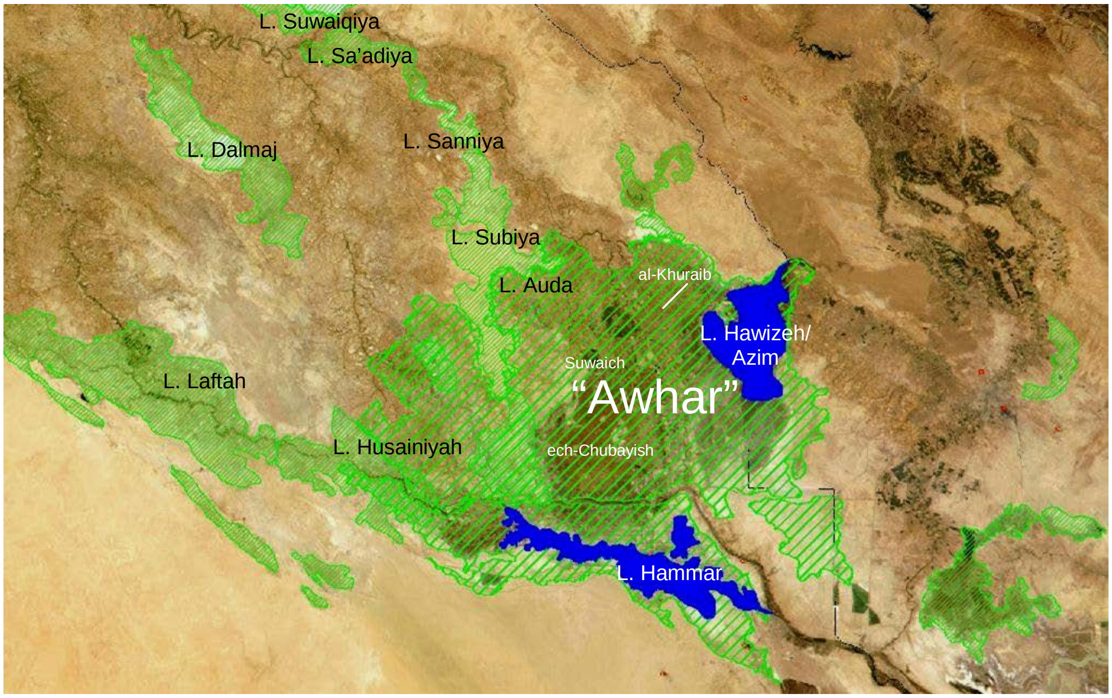

Figure 48: Modern wetlands, combining Figure 12 and Figure 44.

(Figure 12) with the marshes of the lower Tigris–Euphrates inner delta (Figure 47). That delta itself formed when river waters infilled a basin scoured from older sediments previously damned behind the Zubair sill. The question, then, becomes: what happened to the twin rivers' outflow during the peak of the marine transgression that created the Awhar basin?

Our current understanding of regional climate cycles and mid-Holocene marine fluctuations make clear the need to account not only for altered coastlines, but for marsh, estuary, and deltaic conditions. In general, sea level rise promotes sediment deposition, as has been better-studied along the lower Ganges-Bramaputra (Dollar 2002: 126), and throughout the Holocene slowing sea level rise has promoted marine delta formation (Stanley and Warne 1994). Orbital imagery has been of prime importance to the study of these landforms, as it allowed entire deltas to be examined in the context of their surroundings (Coleman, Roberts, and Huh 1986: 317). But imagery cannot be interpreted by geology alone, and especially not to ends focused on a human scale. For starters, less than one quarter of deltaic sequence radiocarbon ages are within one-half millennium of predicted age. Old carbon accumulated in upland sediments is reworked and deposited downstream, so that sediment dates are usually too old and inverted up section. Core samples taken at plain surface often appear to be as old as mid- to late-Holocene, resulting in estimates of relative sea level rise and land subsidence that are far too low. Better dating requires a multiple-method dating approach, and especially archaeological material (Stanley and Warne 1997, Stanley 2001).

Through a fortuitous combination of prescience, accessibility, design, and luck, archaeologically speaking the fourth millennium BCE interface between the rivers (Figure 25) and the sea (Figure 45) is among the longest-examined in all of Mesopotamia, and indeed the world. In the next chapter, I move from the geological to the archaeological, with a concomitant change of scale, and discuss where and what that interface may have been (Figure 75).

IV. VISIBILITY AND DELTAIC ARCHAEOLOGY

> …the state of chaos, half-water and half-land, on the fans of southern Babylonia before civilization began its work of draining and canalizing…
>
> ———(Hall 1930: 93)

As discussed in Chapter One, scholars of ancient Mesopotamia have, since late-eighteenth century antiquarians began probing mounds near Baghdad, maintained implicit (albeit understandable) assumptions about the character of the Mesopotamian landscape and its relation to the rise of urban civilization there. Permeating their interrogation of its past was the persistent presumption of a flat, uniform, desert alluvium, devoid of the meanest resource save silt and the occasional shrub, transited by its two great rivers–a sort of Nile valley writ large. But unlike the Nile, the Tigris and Euphrates were viewed as ungentle: their spate brought threat of biblical destruction, not promise of enriching annual renewal. It was not any gift of nature, rather their harnessing for irrigation (in tandem with cattle yoked to the plow), that brought forth from alluvial fertility an unprecedented abundance from which the great cities of the plain were born. Under successive waves of inquiry, that by the early twentieth century had transformed antiquarians into archaeologists and Assyriologists, this implicit view of a vast, uniform desert transected by the life-giving, trapped if not tamed rivers became ever more explicit.

As early as 1930, V. Gordon Childe observed that Near Eastern civilizations arose in riparian contexts. Childe theorized that mid-Holocene drying forced humans, wild grasses, and wild ungulates into ever-closer association near water sources. He postulated that during the Neolithic the close and contested association of humans and animals led—wrongly, as it turns out, in the context of desert oases—to human manipulation and ultimately domestication of both grains and livestock. [60] Said Childe, agriculture, surplus accumulation, and finally social complexity, followed from this “oasis propinquity” (Childe 1957).

While agreeing that the “origins” of Near Eastern civilization were underpinned by Neolithic agriculture, asserting that a more likely hearth of domestication lay in the present-day piedmontane heartland of wild progenitors of both grains and ovicaprids, Robert and Linda Braidwood in a series of 1950s excavations demonstrated that such “oasis propinquity” did not, in fact, characterize the origins of Near Eastern grain and ungulate domestication (Braidwood 1960). Kent Flannery, following the Braidwood’s work in the Zagros on the origins of sedentism, and informed by parallel research in the New World, found that a shift from megafauna hunting to increasingly intense collection of fish, plants, small game, fowl, and mollusks (the “broad spectrum revolution”), not domestication, preceded early sedentism at a small number of favorable locations (Flannery 1969). But this hint that non-agricultural resources might be implicated in paths to complexity was not taken up in the Near East, where such intensification was viewed as a precursor stage on the path to the full sedentary grain and pastoral livestock production, deemed the fundaments of first order for enduring Near Eastern urbanization (Zarins 1990).

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[60] Childe’s theories continue to undergird debate regarding possible bovid domestication near Saharan oases—a literature I will not here review.

Suspicions that the lower plain had not indeed always been as desiccated as it appears to modern eyes led only to a presumption that cultivation, and thence civilization, could (and did) only follow a draining of delta marshes and a drying of the land (Frankfort 1932, Lloyd 1947). For Egypt, similar arguments, for example Baumgartel 1955 and 1970, posited "a swampy Nile delta hostile to all settlement" (Rizkana and Seeher 1987: 21). The widely-circulated third paperback edition of Childe's *New Light on the Ancient Near East,* still in print, summarized and promulgated these views (Childe 1957: 114). The question was left open of why, if domestication originating along the Taurus–Zagros crescent underpinned urbanity, civilizations characterized by monumental architecture and corporate culture first flourished within riparian lowlands of the Nile basin and Mesopotamian alluvium.

Karl Wittfogel, informed primarily by his consideration of great Far Eastern rice economies, asserted that the development of irrigated grain cropping lead to rising population, creating the necessity of enlarging irrigation systems in order to extend cultivation into environments otherwise inhospitable to rice production. According to Wittfogel, the management and labor requirements for maintaining ever-more complex grain irrigation systems drove consolidation of political authority and social control in "hydraulic civilizations" (Wittfogel 1955, 1959). Such functional models, derived from the presumption of a uniform alluvium, dry or drying, with its irrigation-dependent agricultural surplus as cause or effect of consolidated urban-scale social and labor control technologies, posited the end result—of highly elaborated, semiannually irrigated land tenure systems overgrazed in fallow cycles by vast pastoral flocks—as the underlying cause of the precocious flourit of the world's oldest known cities.

Contra Wittfogel, Adams' systematic survey of Mesopotamian settlement systems showed that only *subsequent* to the establishment of sufficient social complexity and concomitant labor organization and control were massive undertakings of hydraulic engineering possible (Adams 1960, 1969, 1981; Adams and Nissen 1972). This reopened debate regarding the processes driving urban growth during the fourth millennium BCE.

Convinced that entirely too much emphasis had been placed on the role of grain cropping as a prime mover, following Rowton (1973) Adams stressed the importance of understanding the mechanics of both agricultural and pastoral production, and natural constraints thereon, From the outset, he understood the interdependence of all aspects of the deltaic Mesopotamian ecosystem, writing:

> While from a distance the Mesopotamian alluvium appears to be an ecologically undifferentiated region, in fact there always have been a number of distinctively specialized subsistence zones within it. [*First,*] wheat and barley cultivation is perhaps the best known, with the prevailing emphasis on the latter being related to the fluctuating effects of salinity. It takes the form of field cultivation on an extensive rather than an intensive basis, both along levee back slopes and the margins of swamps and depressions. A *second* niche consists of garden and orchard cultivation. These summer harvests are small, limited to 10 per cent or less of the areas devoted to the winter cereals by the sharply reduced availability of water; hence they are largely confined to the favorable low-lying areas adjoining permanent watercourses. A *third* adaptation is that of the herdsman, including weeds and stubble in fallow fields (establishing a pattern of symbiosis with cultivators), as well as great enclosed or marginal tracts of semiarid pastureland. *Fourth, the swamps and rivers constitute a subsistence system whose importance is often neglected, serving as the source of reeds…and also of fish….*The important point about these subsistence alternatives is that they were pursued by specialists in whose activities and interrelations

> the formal organizations of the community played a substantial intervening role…(Adams 1969: 48; emphasis added.)

In 1972, he elaborated the list of important marsh resources:

> …the swamps supplied a variety of important subsistence and other resources, including fish, marsh fowl, reeds for basketry, mats, and building, and *fodder for livestock*. (Adams and Nissen 1972: 86; emphasis added.)

He pointed out that a pastoral nomadic–agricultural sedentary continuum existed, along which people and social segments moved. During periods of strong, centralized political control, nomads (often under coercion) became sedentary (and vice versa). While there was no strongly centralized or closely controlled economy, defensible towns became nodes for storing surplus and facilitating and regulating exchange among groups along this continuum. Such centrality was not, however, always sustainable. Clearly, as the above quotes indicate, Adams himself understood wetlands to be an essential component of this agro-pastoral system. He saw a dynamic balance among segments of urban and rural society that required flexible adaptive strategies to flood, drought, and other political and ecological vagaries. He saw towns as playing an important role in organizing long-distance trade and the flow of goods and services between the urban and the rural—based on religious and cultic ties, with political power relying on the threat of force. He stressed that these social institutions pooled resources and risk, and agro-pastoral urban societies thus constituted a form of ecological adaptation in an environment with uncertain productivity and outcome.

But, in the larger conversation that inevitably accompanies a shift in interpretive paradigm, Adams' understanding of wetlands' importance was couched in terms that harkened back to an older wasteful–useful dichotomy, pitting the natural system of water catchment *against* the needs of grain farmers:

> Chronic uncertainties about the availability of irrigation water had…*more serious consequences* in earlier times than in the Warka region today. Coming in the late spring, the Euphrates *floods are badly timed to be of any assistance* in the agricultural growing cycle; in fact, they represent *only a source of danger* to mature field crops as they are about to be harvested. In the absence of modern regulatory mechanisms such as the Lake Habbaniya flood control scheme, and of the more extensive canal distribution system that has been developed in response to currently much higher population levels in lower Iraq as a whole, the local impact of *floods* formerly was *much more serious.* As a result, *seasonal and permanent swamps formed* a much more conspicuous part of the ancient landscape…*Water impounded in the swamps was, of course, largely beyond use* with the available agricultural technology. (Adams and Nissen 1972: 86; emphasis added.)

Livestock were added to the cannon of research in Mesopotamia once and for all, but what also stuck in the larger conversation was the association of flood to danger, and uselessness of water sequestered in wetlands. Outside a very small number of specialists,[61] for the following decade the interrelation that received the most subsequent attention was that between settled cultivators and mobile pastoralists. Thereafter, ground access in the alluvium became ever more difficult and, with the first Gulf War, impossible. In reiterating that extension of sedentary agriculture made possible the hydrologic engineering used to intensify exploitation of arid riverine settings in which, as compared to equal hectarage in rain-fed agro-pastoral economies, exponential agronomic return was possible per unit labor input, this discussion still focused on agriculture, now broadened to include its pastoral component. Resilience

[61] Notably Nicholas Postgate and those primarily concerned with Umma, Lagash, and the Persian Gulf.

and complementarity notwithstanding, it did not focus on privileged access to other resources, nor consider that aridity may not always have been the primary constraint on either polity size or social integration.

Thomas Park, using ethnographic data from the Senegal river basin and historical data from the Nile valley has elegantly shown, even where irrigation is neither required nor used, the role played by privileged access to specific fields in shaping enduring social inequalities among recession agriculturalists, and the role of social institutions in preserving and expanding such privileged access through multiple generations. Park argued that, among riparian and lake basin farmers dependent upon residual (post-flood) soil moisture for grain germination and maturation, "early stratification occurred long before population pressure reached significant levels, and well before regional trade, extensive storage capacity, or elaborate water-management infrastructure became economically significant" (1992: 90). Over time, despite substantial inter-annual variations in yields, and strong egalitarian norms, families who held traditional rights to cultivate fields at even marginally more propitious locations were able to weather famine, garner surpluses, and amass social rank.

Missing the point, some have stressed that Park's work cannot be relevant in Mesopotamia, due to the unpropitious timing of the annual Mesopotamian floods, which arrive too early in the year for fall planting of a winter grain crop for spring harvest, and too late in the year for spring planting of a summer grain crop for autumn harvest. Such criticism implicitly presumes that summer grain crops are the only resource relevant to inter-generational feast or famine; that, even under simple, decentralized regimes of basin irrigation, off-season floods contribute significantly to overall soil moisture, reducing irrigation requirements; that, at the same time, the flood cycle is intimately tied to the greatest enemy of the Mesopotamian farmer: soil salinization, and field location is critical to its management; that, although not useful for grain production, flood recession in vast seasonal wetlands accounts for a large percentage of livestock pasturage and fodder; and that the permanent marshes recharged by the flood are themselves huge biomass producers. Too little investigation of the total resource base has been undertaken to rule out the relevance of Park's findings. The first step of any cultural-ecological approach to lower Mesopotamia must be, not to determine to what fields Chalcolithic urbanizers might have had access, but to *what* they had access.

Due to the vagaries of preservation and re-exposure, not just of sites, but of associated (or associable) terrain features, not all locales are particularly well-suited to the conduct of landscape studies. Of course, this is true everywhere. All terrain evolves through time. In the last chapter, I attempted to show that, insofar as we can assess, from the mid-sixth through the mid-third millennium BCE (and especially during the fourth), southern Mesopotamian towns and cities flourished in a deltaic zone, where rivers met the sea. This finding has significant implications for the comparability of archaeological evidence within the surveyed areas, even across relatively short distances. In order to select the best possible locale for associating early cities with the terrain that once encompassed their hinterlands, we must first address the mechanisms impacting the visibility of both archaeological sites and terrain features in the deltaic alluvium.

In the first section of what follows, I discuss that most characteristic of deltaic processes: the laying down of fluvial sediment lobes by weakly structured distributary channels (see Fluvial Processes, page 83), and the subsequent deflation of those alluvial silts by winds scouring across the deltaic plains. I show that, for the purposes of this study, not all lobes are created equal. Because not all lobes are equally deflated, and deflation within each lobe is not uniform, conditions for photographic examination of archaic surfaces and their associated archaeological sites is nowhere ideal—but some places are closer to ideal than others. Having selected a specific deflationary basin—that of the Warka Survey Area—for closer examination, in the second section I show (1) to what depths it may reasonably said to be “uniformly” deflated (bearing in mind that this process is nowhere truly uniform); (2) that this basin was, indeed, where the twin rivers’ waters met the sea during the fourth millennium BCE; (3) what archaic watercourses are visible, and how these may be dated; and (4) I argue that not all water*ways* across marshlands need be interpreted as water*courses* in the sense of discrete distributaries. In the final section, I go on to associate archaeological sites with these and other aspects of deltaic terrain visible on imagery, finding that towns and cities clustered on “turtlebacks” and levees generally beyond the reach of seasonal flooding, while smaller settlements pushed out onto prograding sediment fans. This suggests a progression beginning in the Chalcolithic ‘Ubaid with opportunistic dependence on littoral biomass, and ending in the Bronze Age Early Dynastic, with intensive usage of what by then had become "agriculturalized" marsh zones—a hypothesis elaborated more fully in Chapter Five.

A. Sediment Deposition and Deflation

The cycle of sediment deposition and deflation can be described as the formation and erasure of a series of lobes, each of which begins as a flood basin, builds up to become a sediment fan, and—in arid settings—deflates as its fine, silty soils are scoured away by wind-blown sand. The head of a depositional lobe is usually an avulsive node, formed where weakly-formed banks are easily breached, especially in flood, as along a slip fault or at the point of (even gradual) descent into lower-lying ground (see Figure 23; Buringh 1960, figs. 92, 94, and 97).[62] At such points, unstable channels are easily diverted—even year-to-year—by the deposition of their own sediments. Depositional lobes are formed where distributary tails enter (even shallow) basins, first forming small bird's-foot deltas, then infilling these to create crevasse splays (Waters 1992; 134–5; see Figure 18, Figure 28). As floodwaters drain off in anastomosing branches, they tend to recollect at the end of the basin to drain out, often as a single channel. Over time, the marshy basin collects sediments, until at some critical mass, water flowing through the basin is (usually suddenly) diverted from the avulsive node to one side of the basin (Stanley 2001). While this does consolidate water flow into a sinuous channel, due to the low gradients and ill-formed banks, this arrangement is particularly unstable. During periods of increased flow, channels may flip to either basin side, divide to both sides, or, at peak, re-flood the basin.

Eventually, the channel consolidates its bed and sufficiently raises its levee so that only extreme flood events—or human intervention—prompt significant diversion. At first, well-drained levee soils become ideal for cultivation and palm gardens, while brackish seasonal shallows produce fodder. As Tony Wilkinson summarizes:

> the potential fertility of the soils varies considerably depending upon topographic and geomorphological location. The soils of levees range from fine sands to silty clay loam, and being raised some 2–3m above flood basins, these are well-drained with relatively low water tables. On such levees conditions for crop growth are good and these non-saline levee soils become used for date and fruit gardens with multi-cropping of vegetables and other plants. Fundamental to an understanding of landscape development is the microclimate and soil climate that is associated with the palm gardens on levees. The advantages of providing ample shade for a lower storey of plants was already well known to the Sumerians as far back as Early Dynastic times, and the tradition has been kept up until the present day (Nemjet-Nejat 1998: 255). According to Buringh, these well-shaded soils have a low soil temperature, high moisture content, a high level of biological activity, little development of surface crusts, and are homogenized by biological and soil forming processes through the upper meter or so. This makes these soils of exceptional quality for agricultural use (Buringh 1960: 149) and provides a stark contrast with the soils developed on similar parent materials in neighboring desertified areas which suffer extreme moisture and temperature fluctuations, are crusted, and become heavily deflated with a surface crust of shells, potsherds, and other cultural debris (Wilkinson 2003: mss. pp. 140–1).

As the basin dries out, if fallow periods are observed, with irrigation its light, alluvial soils may become suitable for grain cropping (Buringh 1957: 38–42).

> Early cultivation [c]ould have taken place in those parts of flood basins that dried out in time for sowing. The timing of this would partly determine the type of crops to be grown, so that supplementary soil

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[62] For detailed treatment, including a comprehensive literature review and recent geomorphological investigations in the upper alluvium, see Buringh 1960, Verhoeven 1998 and Wilkinson 2003: mss. pp. 147–52).

> moisture could be supplied via flood gullies that channeled water through levee breaks. Potential locations for these early stages of irrigation can be recognized as the distinctive deposits of crevasse splays that fan out over the levees (Verhoeven 1998) or dendritic channel patterns radiating out from levee breaks (Buringh 1960). Water flow through levee breaks could be adjusted by human activity, and with increasing scale of settlement and population growth, the channels themselves could be manipulated and lengthened until they too developed levees. Formative stages…may also have included…décrue agriculture during which crops were sown after the retreat of the flood (Kouchoukos 1998: 224). Again supplementary water could come from rainfall or have been applied later in the cropping season (Wilkinson 2003: mss. pp. 156–7).

However, in subtropical latitudes, the marshy organic components of these drying or dried freshwater basins oxidize quickly (Aqrawi and Evans 1994: 772), leaving soils with poor structure and low (or short-duration) fertility. Further,

> in contrast to the levee soils, those of the riverine basins are fine textured (silty clay loam to clay), occupy topographic lows, suffer a high groundwater level, are poorly drained and are usually saline, sometimes markedly so (Buringh 1960: 150–51). The lowest locations within the basins are variously occupied by *haur* and lake bottom soils, both of which experience inundation for at least part of the year, and are even less well drained than other parts of the basins. (Wilkinson 2003: mss. p. 141).

Worse, since they are the result of deltaic progradation, they are often underlain with old playas or sabkha (marine salt panne). Irrigation efforts result in these subsurface salts being dissolved and wicked upward by capillary action into the root zone. Thus, absent sufficient drainage—natural or otherwise—actions taken to ameliorate salinization in the short term—such as flooding and draining fields to flush surface salts—in the long term only exacerbate it. At best, even with irrigation, cultivation becomes limited to salt-tolerant crops (notably barley, with long fallow periods during which basin vegetation transitions to halophytic, steppic scrub. At worst, new salt crusts form, precluding all plant life. In arid regions, these gypsiferous anthrosols are detectable with multispectral imagery like Landsat (Blom 1999) (Figure 48).

If abandoned to seasonal pasturage, left unirrigated and unplowed these areas may stabilize, held by hardy scrub and debris too heavy to be swept away by wind. But subsequent ill-conceived attempts to return them to intensive irrigated cultivation breaks up this surface (Figure 49), so that when again abandoned—as they inevitably are, with no mechanism for coping with salinization—aeolian scour rapidly deflates unconsolidated silts, leaving consolidated levee banks and once densely-settled sites, protected by thick shard caps, pedestaled above plain level.

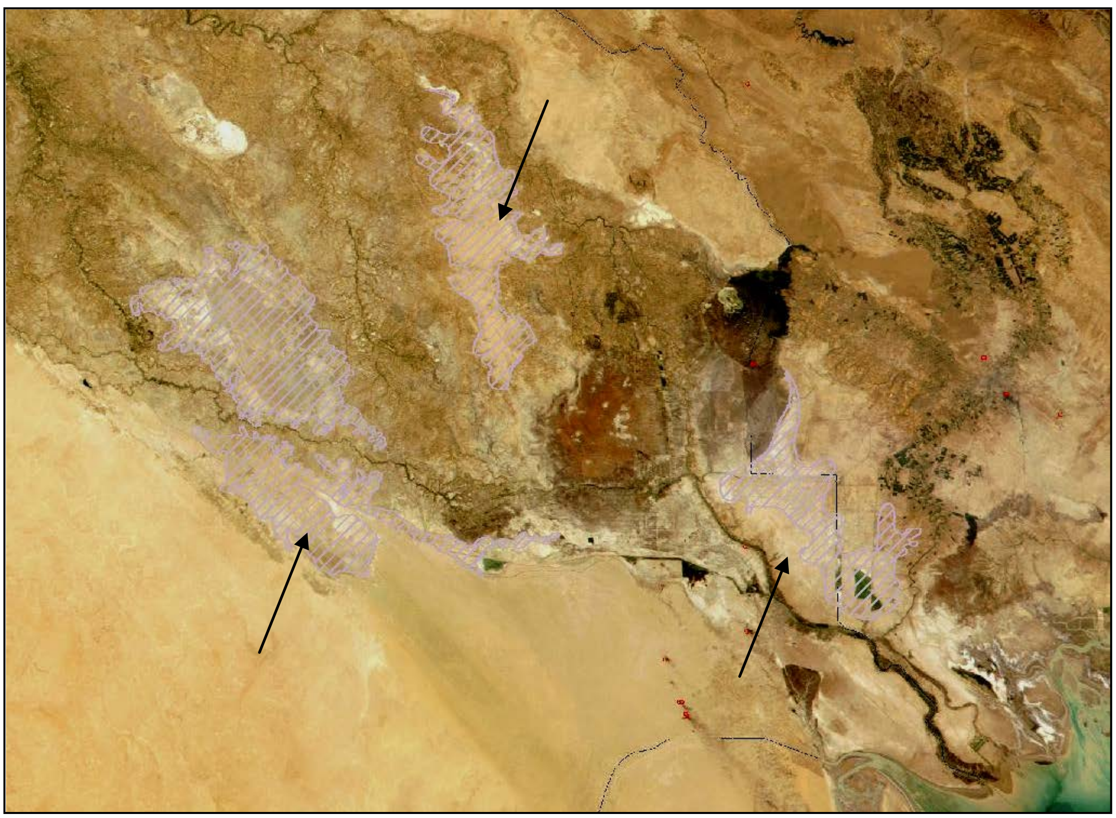

Figure 49: Salinization (arrows) results from repeated soil saturation followed by evaporation of surface water, which dissolves and wicks subsurface salts into the root zone—especially where the legacy of past marine incursion is buried salt panne.

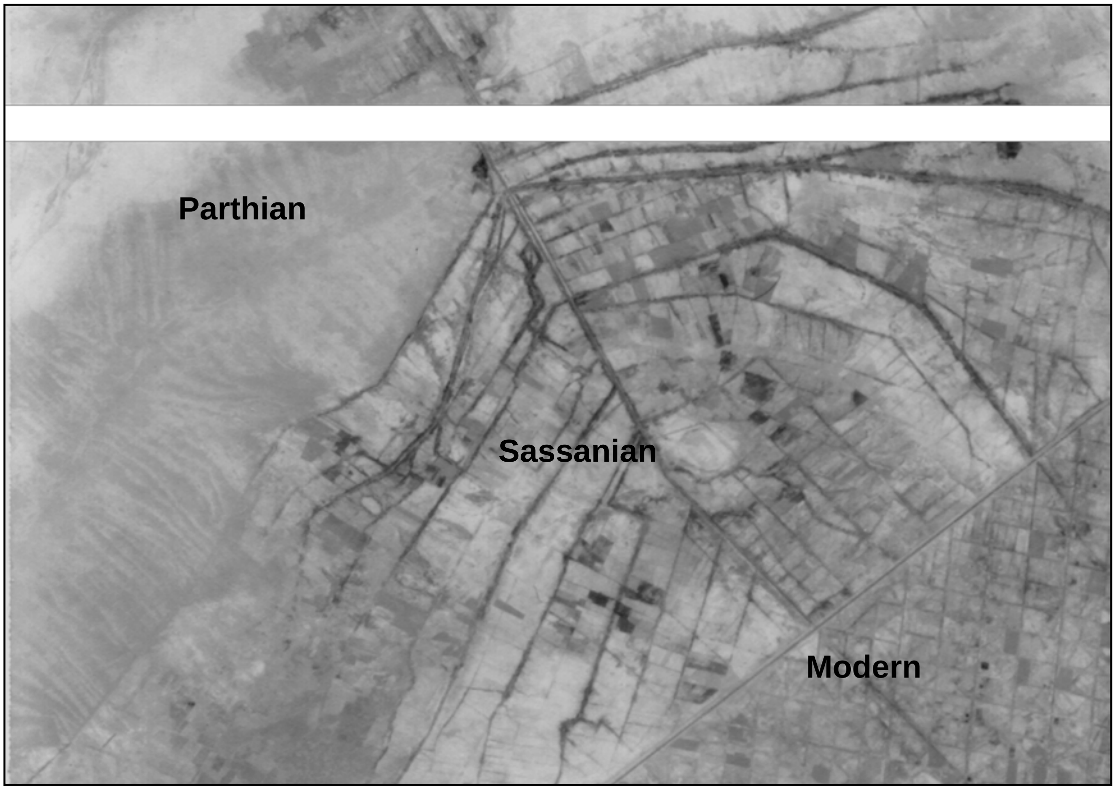

Figure 50: Intensive irrigation systems near Baghdad. The gravity-fed herringbone-patterned Parthian field system carried water down Tigris levee banks during the time of the late Roman Empire. As deposited sediments reduced gravity flow, the irrigation system was re-engineered by early first millennium CE Sassanians. Head works maintained water levels from multiple intakes, allowing re-use of some older Parthian canals. Modern field systems are machine-leveled; water flow requires downstream dams and electrical pumps. Without adequate drainage, intensive irrigation results in soil salinization; abandonment of such systems leaves silts vulnerable to wind erosion.

The geologic cycle of flood basin formation, infilling, and aridification is well-documented for the Pleistocene Abu Dibbis and Tharthar basins (Voûte 1957), re-flooded by 1950s flood-control schemes (Iraq 1956) (Figure 6, Figure 7). Ongoing examples are illustrated by the bird's foot delta, accelerated by rice cultivation between Amara and Qalat Salih on the Tigris (Buringh 1957: 33) (Figure 24); [63]

[63] Rice cultivation is known from attestations in Greek sources of the Achaemenid period (third century BCE) (Ghirschman 1954). However, rice could have been

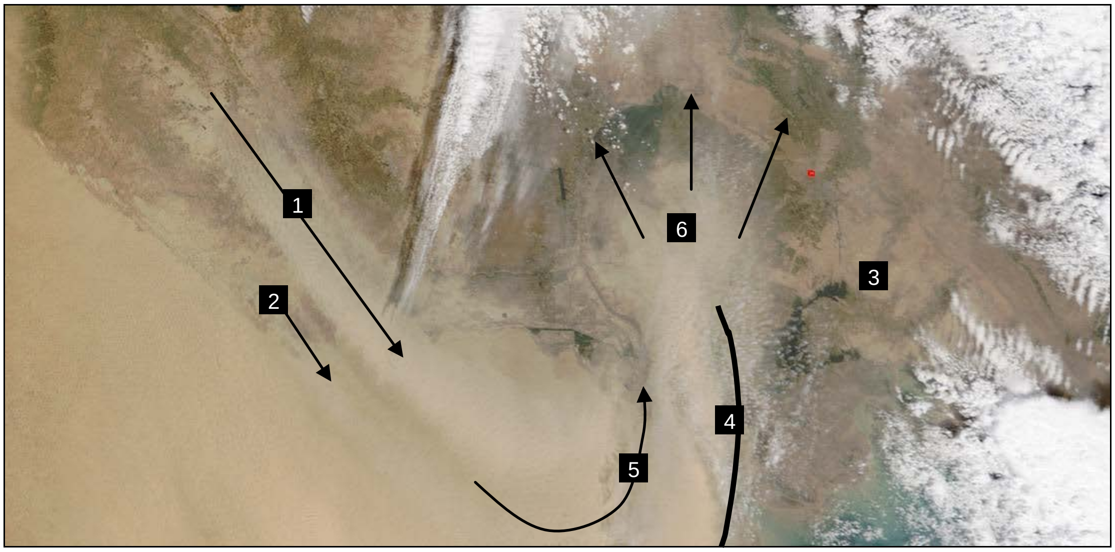

Figure 51: Dust storm over Southern Iraq. (1) High winds, carrying heavy sands from the western desert, scour across the Warka and (2) Eridu Survey Areas. As the storm encounters a high pressure cell over the Karun delta (3), airborne sand piles up in a front across Kuwait (4), and is whipped cyclonically (5) over the desiccated Awhar (6). Exposed light silts are whipped up under the battering (arrows), forming a hazy halo around the former eastern marshes. MODIS 16 April 2003 (Descloitres 2003).

crevasse splays as on the lower Euphrates at Lake Hammar (Figure 18); rapid

salinization following poorly-planned irrigation schemes along a re-activated Dujailia

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brought from India prior to Old Babylonian times. Although there is a paucity of paleobotanical evidence from within the Indus Valley itself, rice may have been cultivated as a monsoon crop in Gujarat at the beginning of the Harappan phase, around 2600 BCE (Lal 1998; Kenoyer 1998: 163). It is also known at Lothal in Gujarat, Pirak in Baluchistan, and the Bengal basin from the late Mohenjo Daro and Indus Decline (1900–1000 BCE) (Kenoyer 1998: 178; Chakrabarti 1994: 255). At Ur, imported Harappan exotica such as shell and shell bangles, carnelian and amazonite beads, along with terra cotta sealings, weights, seals, and seal impressions depicting water buffalo date from 2600 BCE. Textual references to trade with “Meluhha” date to c. 2300 BCE, an Akkadian cylinder seal used by Ibni-sharrum, a scribe of Shar-kali-sharri ca. 2183–2159 BCE depicts water buffalo in the Harappan style, and the “Curse of Akkad” mentions water buffalo along with other imported animals (Kenoyer 1998: 85, 97–98; Zettler and Horne 1998; Postgate 1994: 78, 165). There is no direct evidence of the animals themselves in Mesopotamia before Islamic introduction in canal (Buringh 1960: 183); salt panne formation following flooding with waste water at Lake Dalmaj (Figure 12, Figure 25); and drains engineered to sump brackish water into the Eridu basin. Finally, battered by prevailing northwesterly winds, the green close of marshlands drained within the past decade has already given way to sky-darkening dust storms (Figure 50). While little hard data are yet in from the war zone north of Basrah, clearly, the deflationary cycle is well-begun (Descloitres 2003).

Between the Paleolithic and the present, this progression of deposition and deflation has marched from (north)west to (south)east, creating opportunities for, burying, and re-exposing human settlements (Figure 51). As discussed in Chapter Three, channel formation within the river plain during the early historical periods (third to first millennia BCE) recently has been the subject of considerable, productive analysis (Wilkinson 1990a; Gasche and Tanret 1998; Stone 2002). These studies help provide temporal boundaries for the deposition–deflation cycle of four lobes of the inner delta in which archaeological survey has been undertaken (Figure 51: I–IV, below). Such understanding is important, because the prograding delta is and was not a static system. The lobes underwent differing degrees (and cycles) of sediment deposition and deflation through time, so that archaeological features are not uniformly revealed either within or between them.

Moving backward in time, downward in depth, and southward in detail, the first of these is outlined by the wet-season footprint of Lake Dalmaj (Figure 25A,

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600 CE, but further analysis of butterfat production rates in archaic texts may allow discrimination between *Bos* and *Bubalus* in administrative records. See Brentjes 1969.

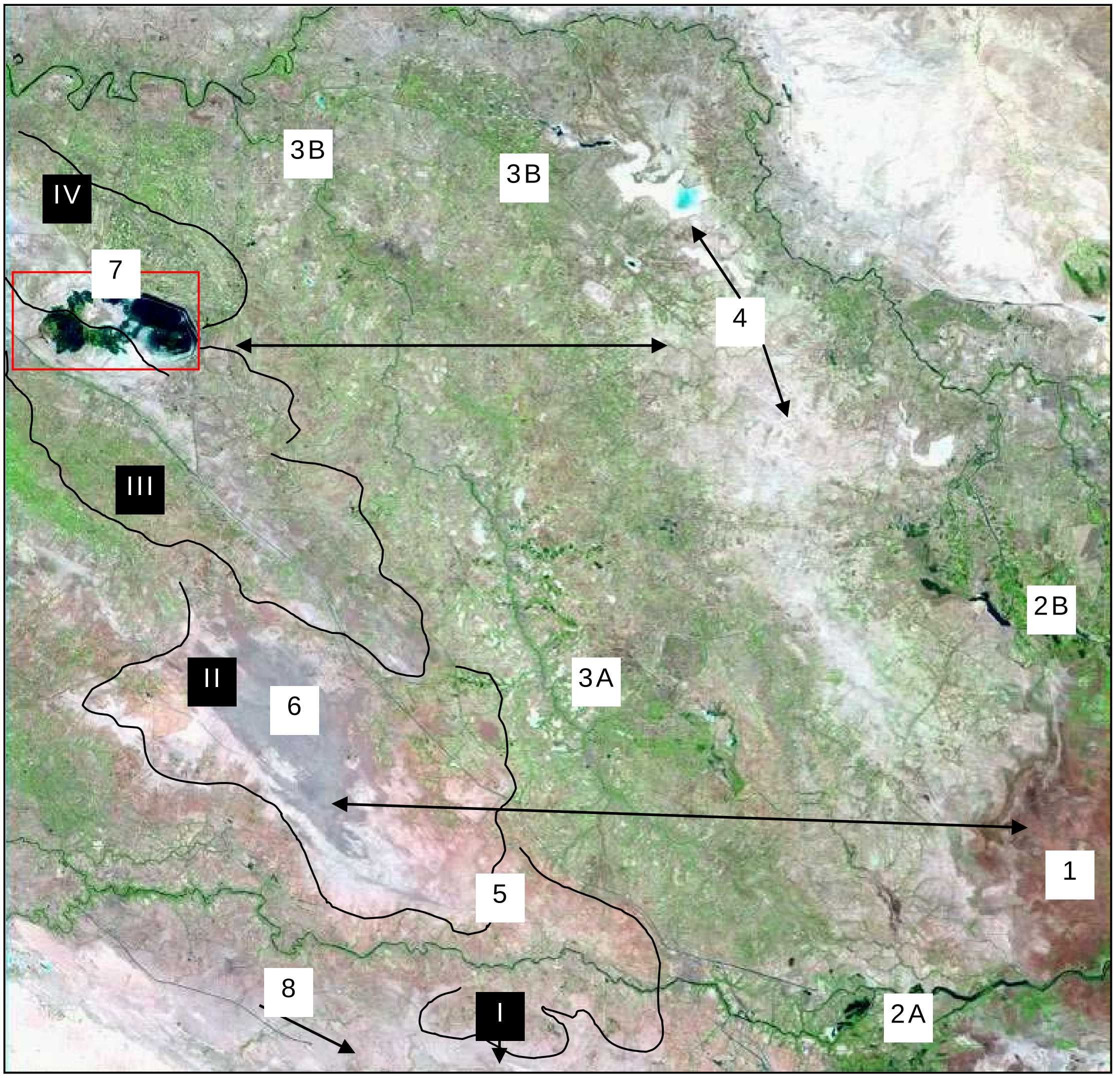

Figure 52: Sediment deposition and deflation. Within the inner delta, fine silts and organic sediments are filtered by marsh grasses and deposited in marshy basins (1), providing opportunity for rapid extension of cultivation down crevasse splays (2A) and at the tails of avulsion channels (2B). This aggrades the basins and reinforces levee zones (3A), which eventually results in water channels silting up, requiring their re-excavation or downstream damming to maintain water flow (3B). Bereft of adequate fresh water or drainage, canal tails build salinized alluvial zones, as downstream from the Dujailia reactivation (4). These zones may be periodically re-exploited for low return through a combination of fallowing and grazing practices (5). Once completely abandoned, lighter soils are scoured away by prevailing winds, deflating the formerly aggraded basins, as in the Warka Survey Area (6). Modern irrigation drains have re-used these as flood- and waste-water dumps, as at Lake Dalmaj in the Nippur Survey Area (7) (boxed: see Figure 52**,** Figure 53**)**, and the Eridu basin (8). Archaic sediment lobes I–IV parallel these visible modern processes. LANDSAT 1999.

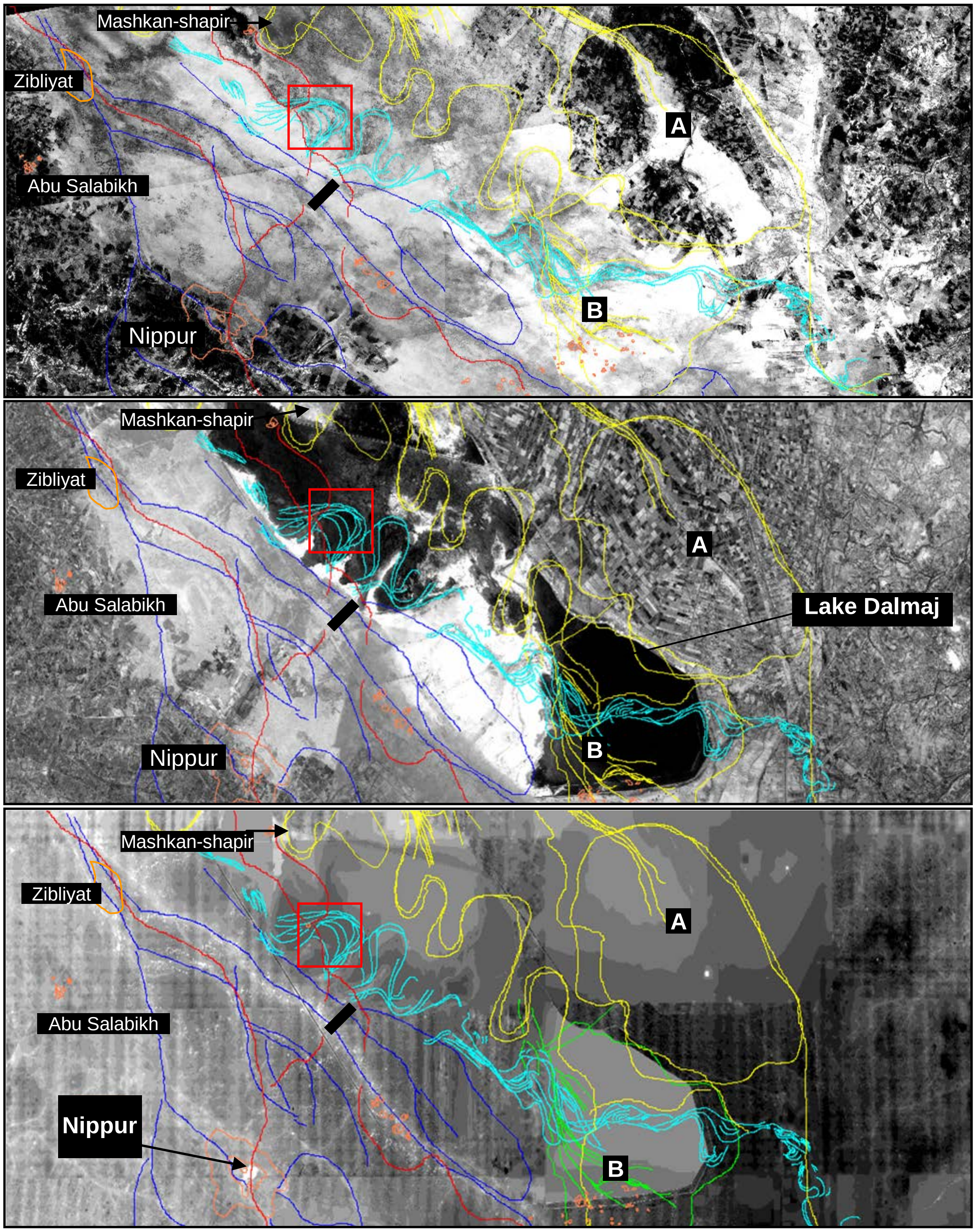

Figure 53: Lobe IV abuts Lobe III along the southern boundary of the Dalmaj Basin, with detail of watercourses at Figure 25. Yellow: Isin-Larsa–Old Babylonian watercourses mapped by Stone 2002, with related sediments (A, B). Cyan: meander system mapped by Adams (1981: 17, 62). Red: Routes indicated by Ur III itineraries, Steinkeller 2001. Blue: NW–SE levee systems passing Nippur. Black bar: "Third River" drain section through post-ED levee. Top: Corona 1968: Basin is dry. Middle: SPOT 1991: Black areas are water discharged from canal tails. Bottom: DTED DEM: Lighter tone indicates higher elevation; bright lines are levees, bright spots are tells. Boxed: Figure 54.

Figure 51-IV, Figure 52). With its head at or to the north of the Old Babylonian city of Mashkan-shapir (NS639), the northwestern extent of this lobe corresponds to the upper half of what Buringh (1957, fig. 1) called the Tigris river plain. Even during the 1970s, although criss-crossed by relict first millennium CE canals, inaccessible, marshy ground comprised at least half this area (Adams 1981). Informed by intensive local survey at Mashkan-shapir, and by examination of SPOT imagery following a rare desert bloom that outlined buried, relict watercourses in sharp relief, Elizabeth Stone (2002) has shown that the Tigris flowed through and on both sides of what is now Lake Dalmaj during the Isin-Larsa period. But it would appear from historical records that by 1739 BCE the southernmost of these channels was no longer active. After 1720, the entire channel bed shifted northward, skirting the upper rim of the basin in favor of its Wilaya bed.

These Isin-Larsa–Old Babylonian boundary channels skirted a flood basin demarcated by salinized, compacted soils and rimmed to the southeast at the basin margins by flood sediments exposed by aeolian deflation, no doubt exacerbated by abandonment of a Sassanian irrigation system transecting the area. For the past two millennia, soil moisture in parts of the marshy basin center has remained sufficiently high to stabilize soil surfaces and support reinforcing vegetation—as is clear from the intactness of the relict Sassanian field boundaries. As I will explain in detail, early sites noted in the area were patchily exposed by the excavation of later canals—or rather, by the cycle of erosion set off when the field systems they watered broke up a stable surface, and then were abandoned to the vicissitudes of the desert wind.

At its southern boundary, the Dalmaj basin abuts earlier sediments, apparently deposited by Euphrates waters in a sediment lobe extending roughly between Nippur and Karkar (WS04, ‘Ubaid 3–Old Babylonian) (Figure 51, III). Corresponding to the lower half of what Buringh names the Euphrates river plain (1957, fig. 1), the head of this lobe is partly buried, but lies essentially somewhere between Zilbiyat and the first scroll of a large, relict meander system (Figure 52, Figure 54). Based upon analysis of Ur III-period shipping itineraries, Piotr Steinkeller (2001) argues that at that time the Euphrates flowed along this lobe’s western edge, via Nippur, Kisurra, and Uruk, to Ur. At the same time, a branch of the Tigris, apparently skirting the southern edge of the Dalmaj basin, continued southeast via Adab and Karkar. Therefore, the Tigris, from its avulsive node near Mashkan-shapir, must have moved to the northeast side of Lobe III between the Ur III and Isin-Larsa periods. This diversion did not, however, divert water from the Ur III channels south of Karkar, which continued southward, via Larsa, to Ur. Thus, the boundary channels broadly date Lobe III to between (at its western edge) 2150 BCE and (at its eastern border) 1750 BCE.

This is important for the present study, in that a cluster of Early Uruk sites near the head of Lobe III, coincident with the meander system northeast of Nippur that demarcates the boundary between it and the Lake Dalmaj basin, were used by Adams to tentatively date that meander system to the fourth millennium BCE (Adams 1981: 17, 62). Because the amplitude and periodicity of this meander belt were not as high as that of the modern Tigris, now 25 kilometers away, it was thought that this represented an archaic course of the Euphrates, perhaps with an admixture of Tigris water. Such a date would assume that during the fourth millennium BCE the river had already taken up a relatively unitary course, sufficiently stable and of sufficient velocity to build a meandering floodplain in that area.

However, this dating is problematic. First, three-dimensional views make clear that the tails of this meander system not only coincide with Old Babylonian and later channels mapped by Stone, but flow over and down Old Babylonian and later sediment fans at the outflow of the Dalmaj basin (Figure 53). There is a distinct discontinuity between the most prominent meander scrolls associated with early sites, their "continuation" atop the sediment fan, and those resuming flow on the downstream side. This "system" would appear to conflate two or more different periods. Secondly, Kris Verhoeven has shown that north of Kish, until some time between the late Old Babylonian period and 900 BCE, the Euphrates still had not made the transition from multiple, anastomosing, sinuous channels to a unitary, meandering one (Verhoeven 1998: 238–39). To the west, at Abu Salabikh, Tony Wilkinson has shown that, despite exposure by deflation of the tops of Uruk-period mounds, the levees and channel bed of the Uruk-period watercourse was buried beneath substantial, later sediments and did not follow the same course as the subsequent Sassanian one (Wilkinson 1990). Further east, Wilkinson's examination of deep cuts (made during "Third River" drain construction) through the major levee that passes northwest–southeast between Nippur and the scroll system (see Figure 52) shows that the wide channel exposed by the section

> being sunk slightly below the contemporaneous flood plain level, appears not to have been an artificial channel, because the lack of

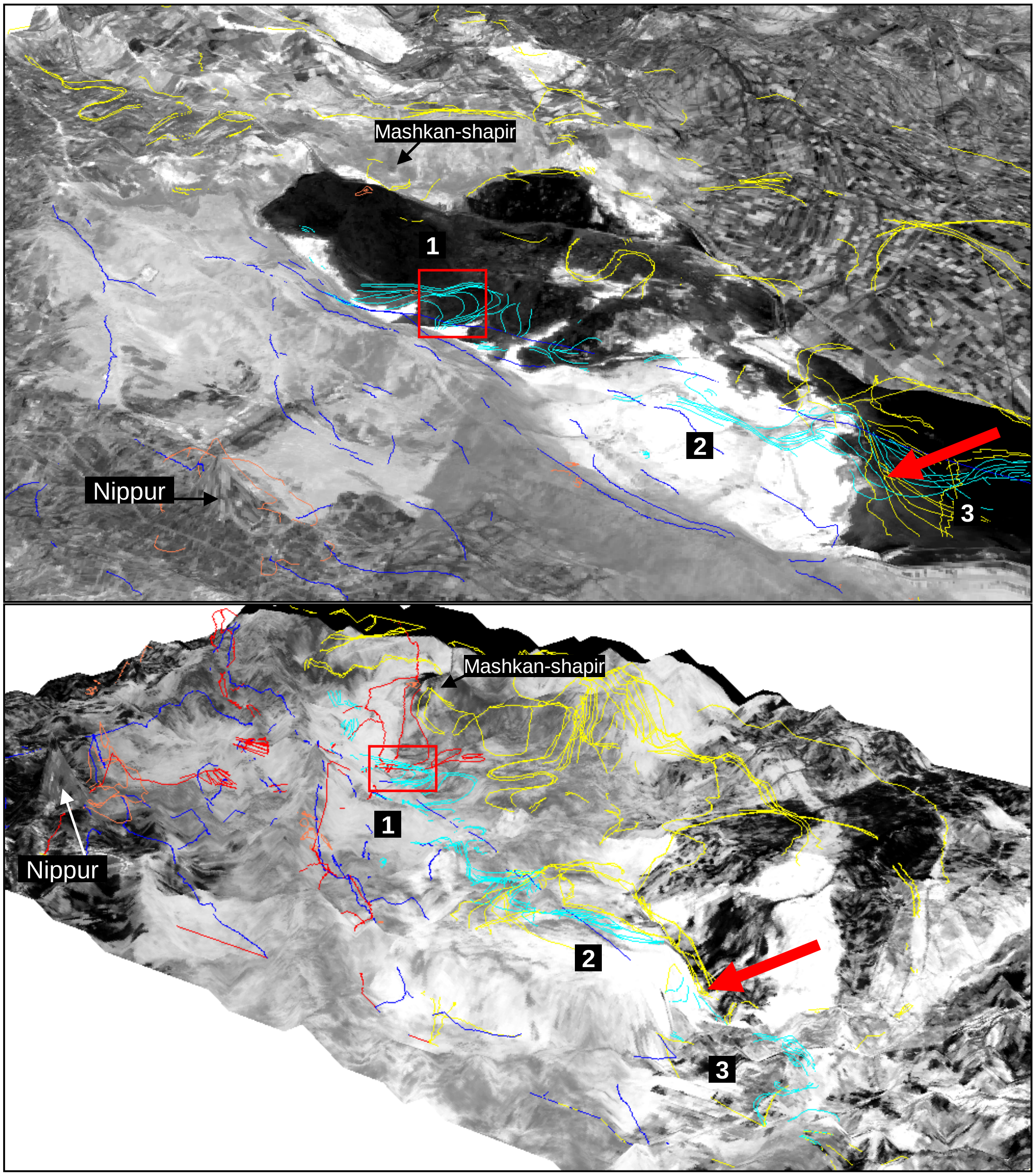

Figure 54: 3D Views of the Dalmaj Basin, with vertical relief exaggerated 2000X. Top: SPOT 1991. The meander “system” (cyan) northeast of Nippur (1) begins in a deflated basin now filled with water, (2) “flows” up and over a sediment fan possibly associated with a Old Babylonian course of the Tigris (Stone 2002), but more likely resulting from the tail of a Sassanian canal, (3) into a lower (also flooded) basin. Bottom: Corona 1968, rotated to show more clearly the drop and discontinuity between the meander scrolls atop the sediment fan, and those resuming flow on the downstream side (red arrow). This “system” therefore conflates two or more different periods. Color key: see Figure 52.

> obvious upcast deposits alongside the canal implies that it had not been subjected to large scale cleaning out operations. This section exposed a thin layer of cultural deposit of Ubaid/Uruk date *located on the flood plain* which then ceased to aggrade around ED times, *and was followed by* the accumulation of deposits of a major levee. Finally, the upper grey brown blocky silty clay represents an irrigated soil which apparently *blanketed the entire terrain from levee to flood basin*. The stratigraphic position of this soil is late and it can be inferred to be the result of Sassanian–Early Islamic irrigation that distributed water across the entire plain in the area…Whereas [in the north, the Belgian] section demonstrates that much of, or even the entire, Euphrates flow passed through the Sippar area until the second millennium BCE, [this] channel can only have conducted a small proportion of Tigris or Euphrates discharge. From its stratigraphic position in relation to the main dated sequence, both the canal and the alluvial channel can tentatively be dated in the range Ubaid through Early Dynastic, whereas *the levee post-dated the Early Dynastic and appears to correspond to the large channel system that persisted from ED through to Early Islamic times.* The shift from a low energy flood plain environment to higher-energy sands was clearly abrupt, and it may have resulted from…the avulsion of a new river course along this line…(Wilkinson 2003, p. mss. 143; emphasis added).

Finally, as has long been known and as is clear on a 1968 CORONA image, both the Uruk sites and the meander scrolls were exposed by wind erosion (Figure 54). Since 1968, the deflation boundary has remained stable at its western edge, but has advanced about 100m to the southeast, revealing further details overlying the meander scrolls. Sixteen sites surveyed within this image area are plotted (Adams 1981). Of these, eight had fourth millennium BCE material at the surface (black, yellow). Nine sites had first (dark blue) or second (lilac) millennium CE material directly associated with surface canals unrelated to the scrolls. The canal head-works between sites NS835 and NS836 are part of an extensive Sassanian system that apparently regulated water drawn southward from the Tigris. The strong association of Early–Middle Uruk sites to these later Sassanian fields suggests either that site visibility is the result of

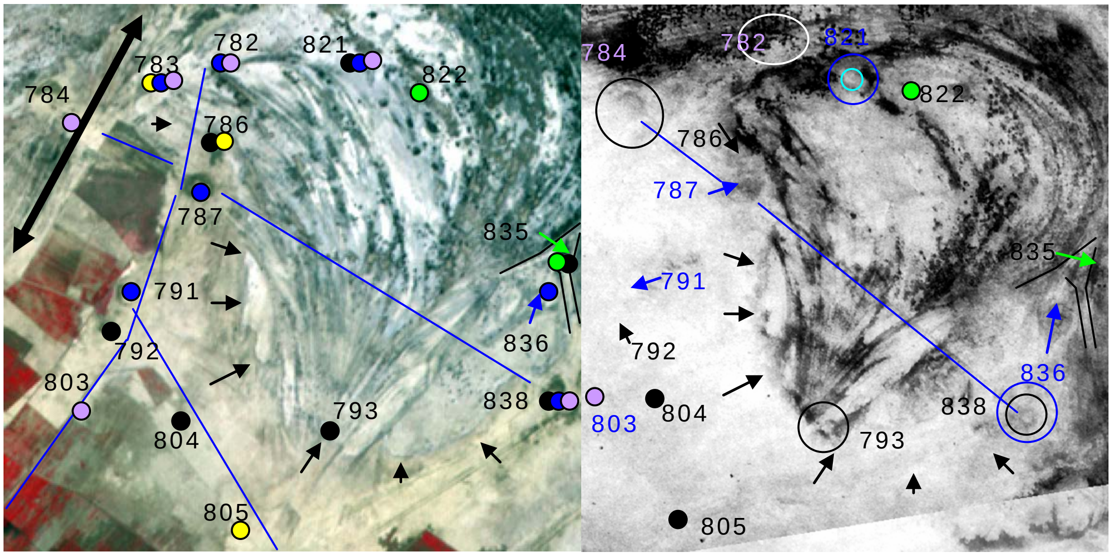

Figure 55: A meander scroll northeast of Nippur. Modern re-introduction of irrigation into long-abandoned field systems (left, red) has increased subsoil moisture and stabilized windblown silts. *Terminus ante quem* for the scroll (bold arrow, left) is Isin-Larsa (Gasche and Tanret 1998; Stone 2001). Small arrows show limits of wind scouring to a salinized surface. Numbers refer to the Adams 1981 Nippur Survey. Black: Early–Middle Uruk. Yellow: Late Uruk–Jemdet Nasr. Green: Cassite. Dark blue: Parthian–Sassanian. Lilac: Islamic–Modern. Note that the Uruk sites are more correctly associated with the undeflated soil than with the scroll itself. See also Figure 17B. (L) ASTER, April 2001 (R) CORONA, May 1968

localized aeolian deflation following abandonment of those irrigation systems, or that they had been pedestaled by earlier deflation, and subsequently surrounded by the later irrigation sediments (which are again being deflated). In either case, there is no necessary relationship between the sites and the meander scrolls themselves.[64] Further deflation of the remainder of the Dalmaj basin might well show that, rather than being directly associated with any particular watercourse—these being mostly buried

[64] Earliest/Latest site occupation: NS 782: Sassanian/Recent, NS 783: Late Uruk/Sassanian-Early Islamic, NS 784: Late Islamic/Recent, NS 786: Middle Uruk–Jemdet Nasr, NS 787: Achaemenid–Parthian, NS 793: Early Uruk, NS 803: Late Islamic, NS 804: Early Uruk, NS 805: Late Uruk, NS 821: Early Uruk/Sassanian-Early Islamic, NS 835: Early Uruk/Cassite-Middle Babylonian, NS 836: Achaemenid/Parthian, NS 838: Early Uruk/Parthian+Early Islamic.

beneath the levees and sediments of the later Lobe III levees—the earliest sites may instead be associated with the edges of the flood basin.

Insofar as any relationship between these sites and their surrounding terrain may be divined, general models and specific models of deltaic flood plain evolution in Mesopotamia (discussed in Chapter Three), the sketchy geoarchaeological investigations from this area, evidence from imagery, and archaeological data all point to an anastomosing, deltaic regime of flow during the fourth millennium BCE, not to an evolved river plain characterized by a developed, unitary, meandering channel contained by levees. Before Early Dynastic times, Nippur and other, smaller sites appear to have skirted a flood basin, now overlain by the later levees and silts of lobes III and IV. Any search for large, centrally-managed irrigation schemes tapping directly into “the” Euphrates or “the” Tigris at this period is likely to prove futile—as is a search for colonization of “newly dried” land. Even now, all along the boundary of the Tigris and Euphrates tectonic sub-zones, the major constraint on (or opportunity for) agricultural practice is the rivers’ tendency to fragment into unstable distributary channels (see Figure 6, Figure 25). Until the later third millennium, when falling sea levels may have accelerated water flow, accounting for channel consolidation and levee aggradation noted in the “Third River” cut, during the fourth millennium land would have been, if anything, wetter than previously. But the point here is not to quibble with the validity of earlier settlement distribution analyses—it is that, in order to examine fourth millennium BCE sites in association with watercourses or terrain visible at or near the surface, we are well advised to look elsewhere.

Each of the four lobes discussed (Figure 51) naturally has a piece of a tale to tell for any period, and as we saw in Chapter Three, in all of them major levee systems have proved remarkably durable. But, in terms of their suitability for associating point data with a broader terrain and landscape study (and especially for a study such as this, based on the use of surface imagery), they may be broadly classified. As discussed above, deeply-scoured "potholes" that provide a window into Early Uruk settlement notwithstanding, Lobe IV would seem for the most part to preserve channels and sediments of Isin-Larsa and later date[65]—and in any event, much of this terrain is now under water (and modern agriculture). Lobe III boasts near the surface well-defined levee systems, some of which would appear to have occupied substantially the same beds since at least Ur III, if not Early Dynastic times. It is in Lobe III as well that the significant excavations at Nippur, Adab, and other cities associated with those levees lie. But imagery clearly shows that Lobe III is far less deflated than the others, and its sediments vary in depth from 5.2m at Nippur to as little as 1m at Shurrupak and Adab (Wilkinson 2003, mss. p. 145), where it abuts Lobe II. One might say that, rather than comprising a "no man's land" between settlements of the Nippur-Adab and Uruk regions (Adams 1981, Pollock 1999), the consolidated, southeast-trending levees through this zone have created a "no wind's land" that has both inhibited deflation (of the consolidated materials) and re-covered it where it has occurred (by trapping windblown particles). In any case, there, too, any early surfaces that may have been exposed have since been returned to irrigated agriculture.

[65] In keeping with models positing progressive, eastward migration of the Tigris bed.

Therefore, in the next section I turn to Lobe II—the Warka Survey Area. Never covered to the same alluvial depths as the more northerly lobes that became the river floodplain, as we shall see, this area has for the most part been stripped of sediment down to Late Uruk levels. In patches, it has been scoured even further, especially along the windward edge of archaic levees. While it has been much-crossed by later (and very substantial) irrigation systems and their levees, much of the (especially Late Uruk) settlement pattern is well-exposed, and for small areas it is even possible to see where associated terrain may have been well-preserved.

B. Visible Watercourses

Proceeding southward into what Buringh called the Euphrates delta plain (1957, fig. 1), we find the deepest desert of the lower alluvium; a wind-scoured, desiccated plain, transited by dune fields (Figure 55, Figure 56). In this heavily deflated zone, where average surface elevation drops barely two meters per 100 kilometers (Cotha Consulting Engineers 1959: fig. 4.1), few relict meanders are visible. Instead, from the thirty-second parallel to the high desert lands skirting the rim of the Eridu depression, surface morphology is strewn with relict landforms characteristic of an inner delta. This suggests that conditions similar to those of the twentieth-century Awhar, the Shatt al-Arab, and the delta mouth on the Persian Gulf would once have been extended along then-extant river distributaries north and west of the present-day Shatt al-Gharraf, into the Warka and Eridu survey areas (Geyer and Sanlaville 1996, Sanlaville 1996: 96, Aqrawi 1997, Kouchoukos 1998).

Is this basin indeed where the twin rivers' waters met the sea during the fourth

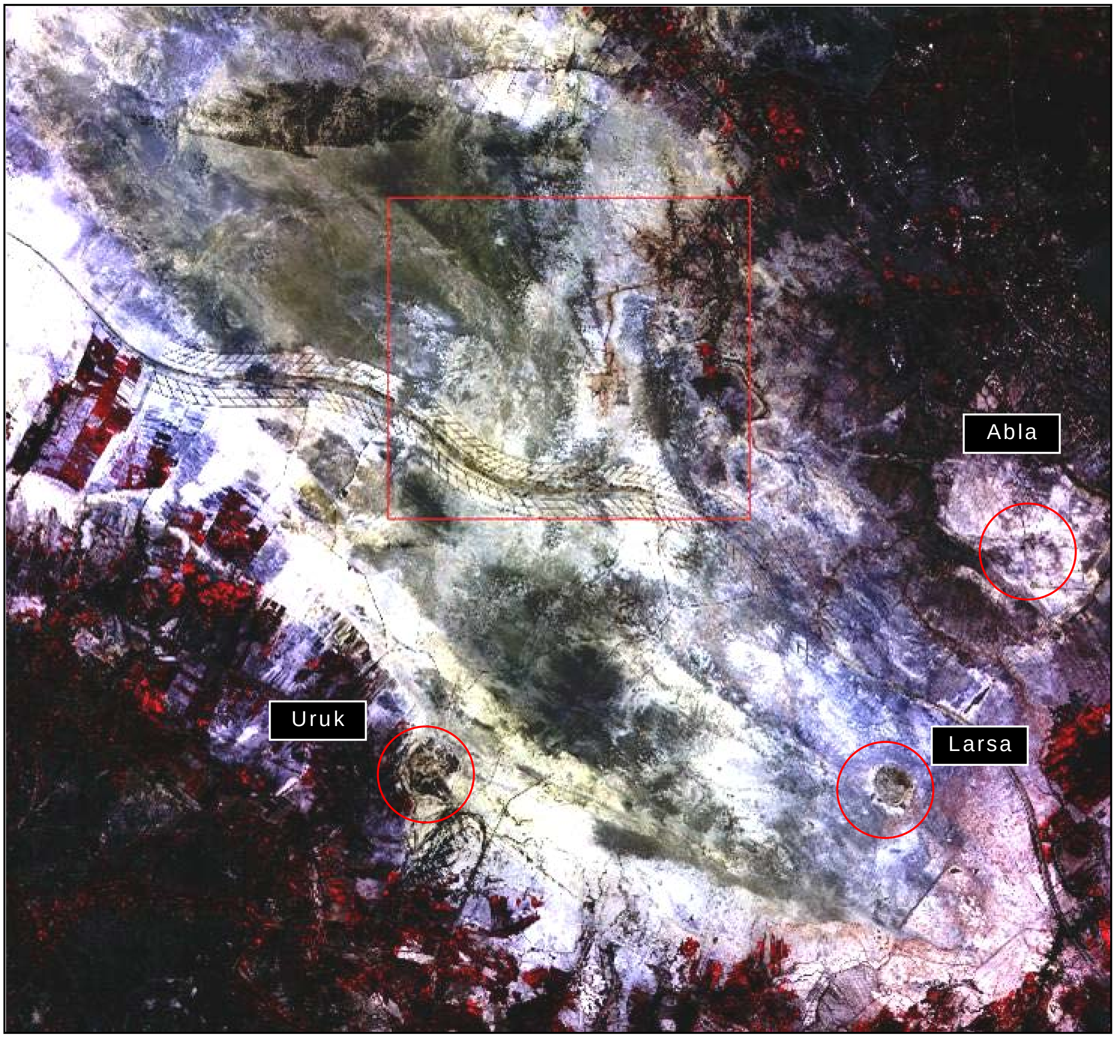

Figure 56: Warka basin. Highway construction snakes across the dry basin (grey), ringed by dark, waterlogged soils and crops (red). Boxed: see Figure 60. ASTER, April 2001. Bands 1, 2, 3N with equalization enhancement.

millennium BCE? What archaic watercourses are visible, and how these may be dated? To what depths may it reasonably said to be "uniformly" deflated (bearing in mind that this process is nowhere truly uniform)? To the degree that we can see archaic water*ways*, how should we interpret them?

Lobe II appears to have been built from overlapping avulsive fans that extend from just south of Shurrupak (near WS20) to the vicinity of Larsa, and from just southof Karkar to Umma and Bad Tibira (Figure 56). South and east of a line between

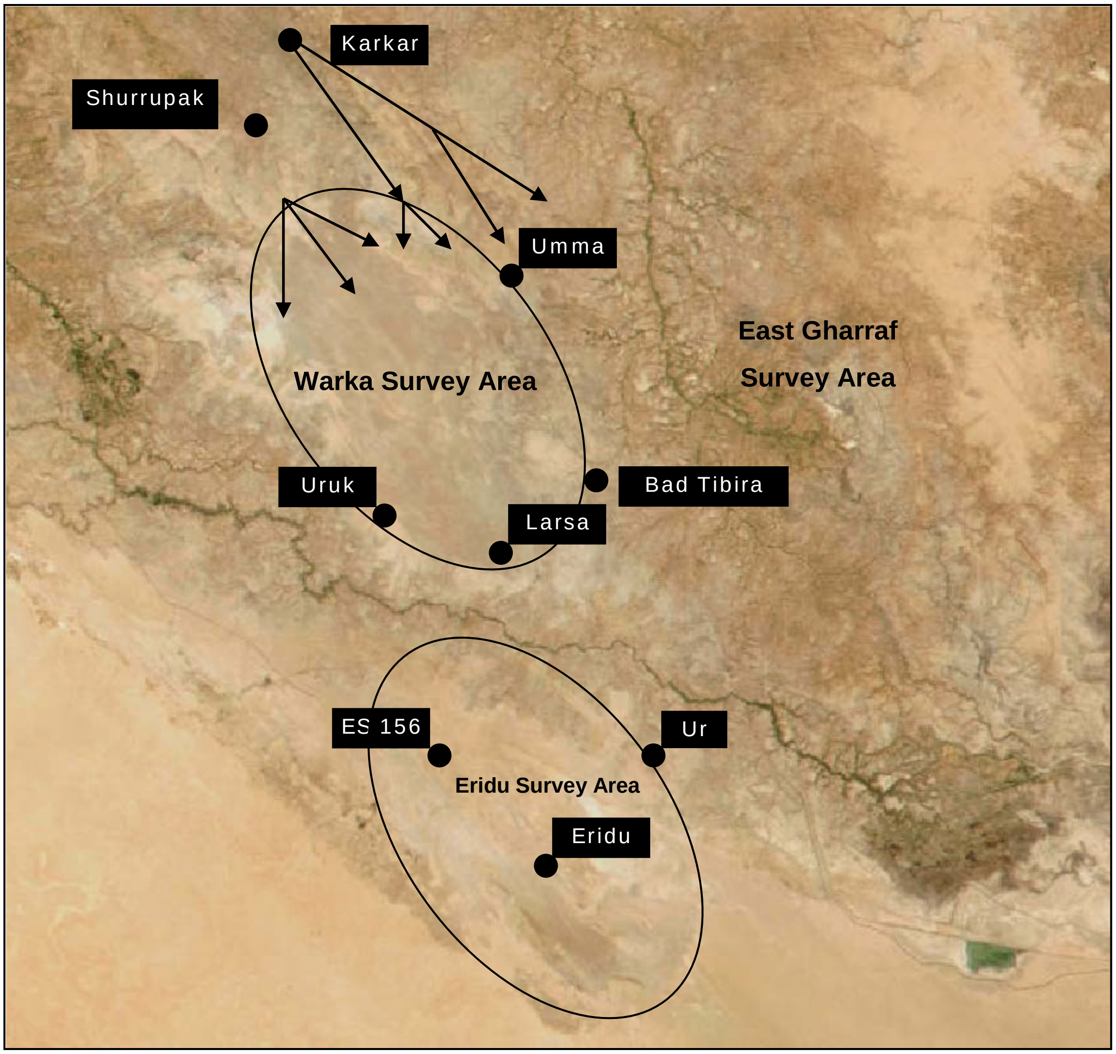

Figure 57: The Warka (Lobe II) and Eridu basins. Arrows indicate sediment fans referenced below. See also Figure 49, I and II; Figure 55. MODIS April 2001.

Shurrupak and Karkar, an area where watercourses are attested from the earliest historical times, much of the ground was covered by standing water, drifting dunes, and accumulated alluvial silt. Boundary channels here are more difficult to discern: in part, because the eastern margin is ill-defined and remains largely unsurveyed (Figure 90); in part, because thanks to the severity of deflation, so many apparently intersect

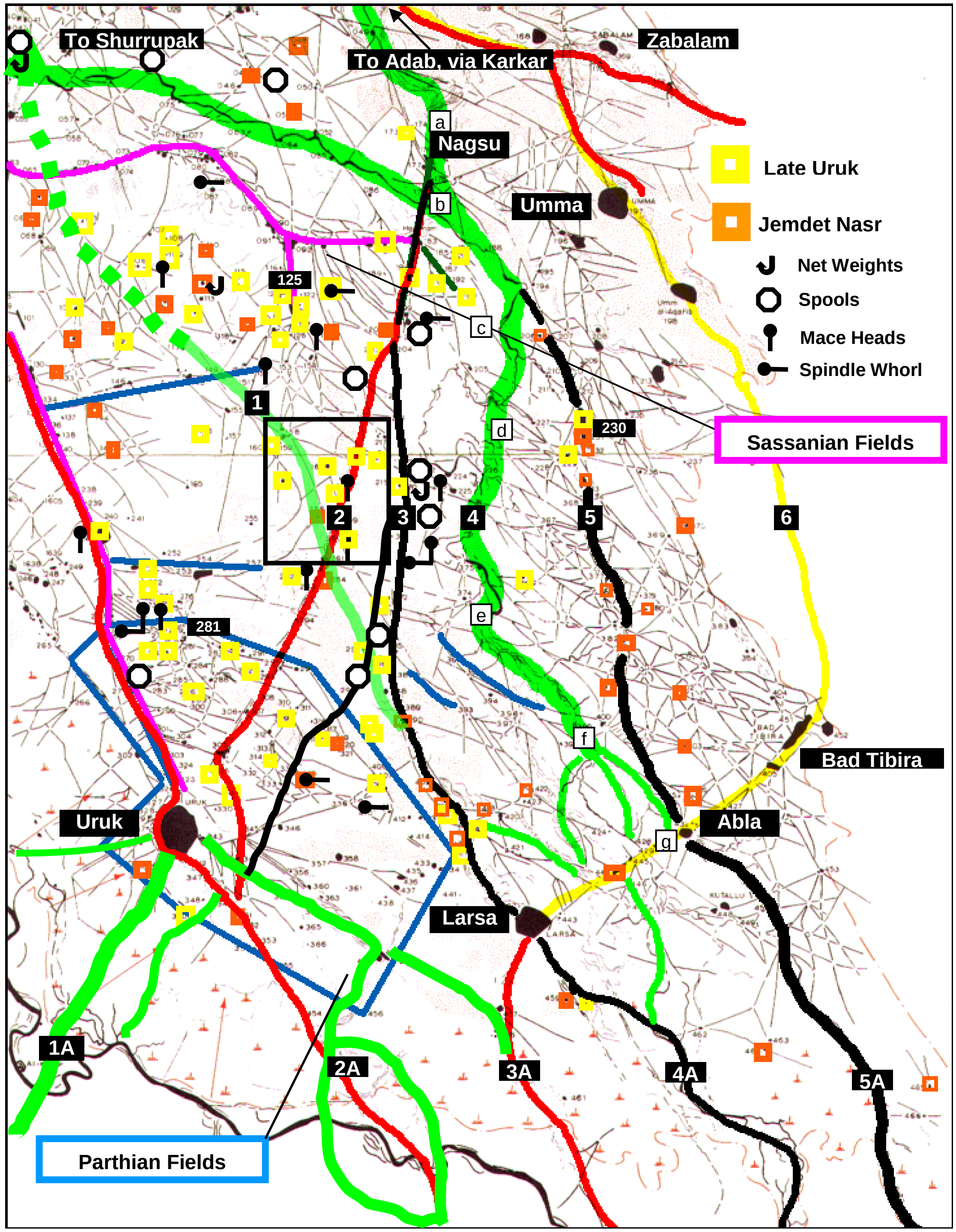

Figure 58: Late Uruk–Jemdet Nasr sites, with Parthian/ Sassanian field systems in the Warka Survey Area. Sites are most visible where surface deflation has followed abandonment of later field systems (for earlier periods, see Pournelle 2003). “Canals”: 1. “Isin?” 2. Uruk (“Iturungal”). 3. Larsa. 4. Shatt al-Khar. 5. Abla. 6. Bad Tibira. Boxed: see Figure 60. See also Figure 20, Figure 25, Figure 75.

and interconnect (Figure 20, Figure 57). Steinkeller's study shows the western (Euphrates) boundary to have been active in Ur III times; as was a Tigris channel or canal serving Uruk from the northeast, departing from what is now the Shatt al-Khar levee near site WS175 (tentatively identified as Nagsu). Clearly, fresh water must have served the hundreds of sites recorded in this basin from earlier periods. But have any of these pre-second millennium BCE watercourses left traces visible at the surface? What dates can we assign to those we can see there?

As shown at Abu Salabikh, whether evidence of early watercourses can be seen at today's plain surface is problematic—and in this instance, not only because of subsequent sediment deposition. Patches of pebbles and rocky areas recorded on military maps suggest pockets of deflation so severe as to expose pre-Holocene colluvium (Soviet Union 1991b). At 'Oueili, south of Larsa, not only had wind in some cases bared the tops of Pleistocene buttes; it had ablated most of the 'Ubaid 4 and portions of the 'Ubaid 3 strata of the mound itself (Forest 1987: fig. 1b). On the other hand, as for the Dalmaj basin, the visibility of Uruk-period settlements is very strongly correlated with subsequent Parthian (radiating from Uruk) and Sassanian (along a canal running eastwards from WS60) irrigated fields. These regions were clearly, deeply deflated subsequent to abandonment of these systems. Along the eastern half of this flood basin, five identifiable levees splay in southerly directions from the avulsive node north of Nagsu (WS175). Two (the Bad Tibira and Abla "canals") flow to the east of, and another two (the Uruk and Larsa "canals") to west of, the fifth—the broad levee now capped by the intermittent trickle of the Shatt al-

Khar (Figure 57).

As shown in Figure 58, the total number of sites of any period visible along the length of the Larsa and Bad Tibira "canals" tends to vary with site visibility along the main (Khar) levee. In other words, where irrigation operations have spread sediments on and laterally outward from its banks, no sites of any period remain visible at the surface. However, along the Abla canal, the number of third millennium BCE (Jemdet Nasr–Early Dynastic) sites spikes sharply, and then falls to none for several millennia.

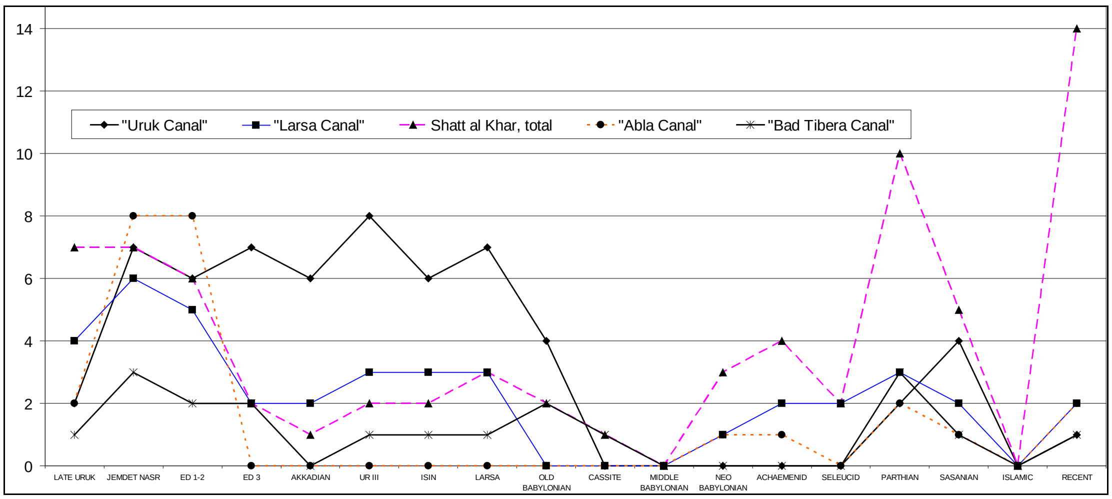

Figure 59: Number of sites along Nagsu–Uruk/Larsa Waterways (x), by period (y).

Has deflation merely stripped this surface to third millennium strata, or is this indeed a preserved fragment of a subsequently abandoned watercourse? A process visible along the Uruk canal, which Piotr Steinkeller argues was known during the Ur III period as the "Iturungal," or Tigris, suggests that the latter scenario is at least possible (Steinkeller 2001). Many sites from all periods of the third millennium BCE were situated along this waterway to Uruk, made especially visible because it passes through the severely deflated center of the Warka flood basin. The straight line of a

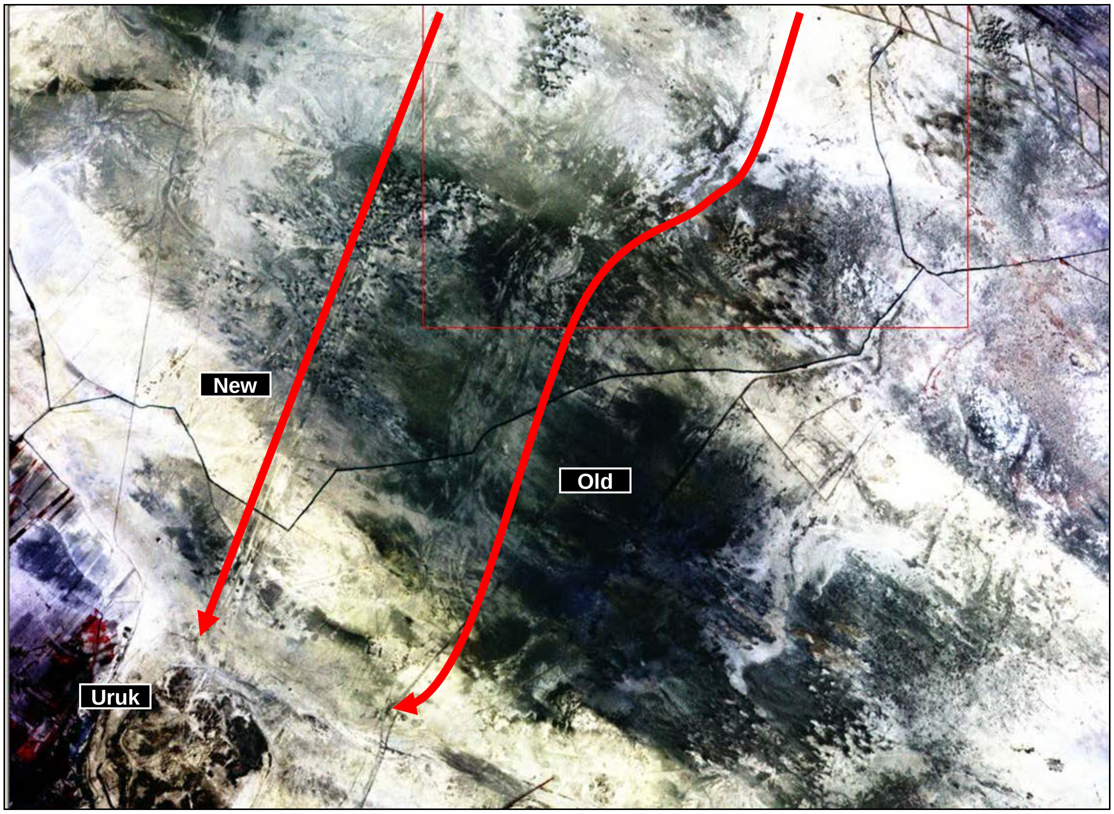

Figure 60: The “Iturungal.” The newer version, running from Uruk via WS190 to WS175, is paralleled by an older levee skirting among turtlebacks enroute to a junction near WS386, previously obscured by dunes. ASTER 2001 Bands 1, 2, 3N.

posited route for the “Iturungal” of Ur III times, connecting Uruk with the levee junction near site WS175, or Nagsu, an Ur III-period shipment transfer point (Steinkeller 2001) suggests that a later, excavated canal recaptured the route of water traffic among earlier, smaller-scale catchments dominated by turtleback settlements. On imagery, two “Iturungals” are clear: the smartly engineered and executed line probably re-dug in Sassanian times, and a parallel, heretofore uncharted, older and gentler levee (Figure 59), passing a more modest distance to a junction near WS386

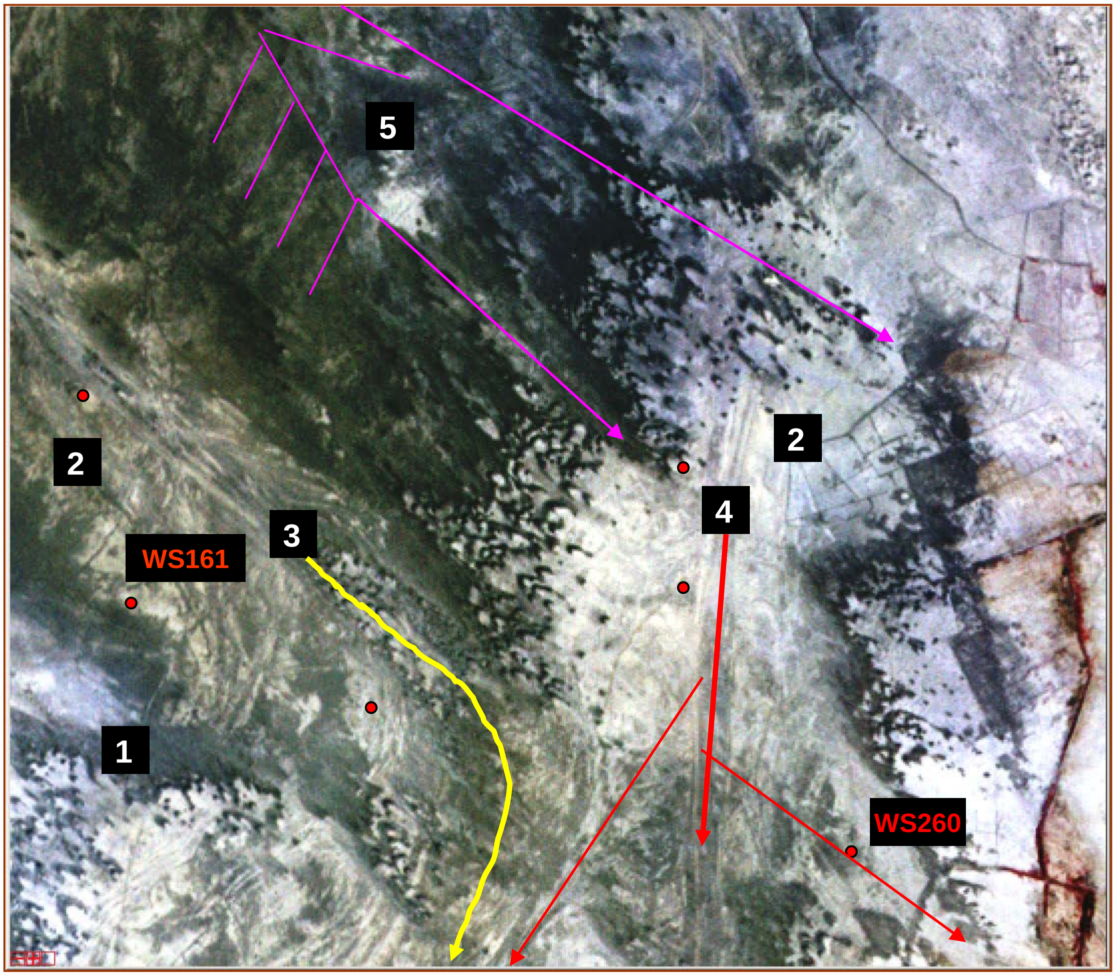

Figure 61: Relative dating of watercourses south of WS125. 1. Most deeply deflated plain surface, with dunes piling up against the "Iturungal" levee. 2. Decayed "Iturungal" and "Isin canal" levees. 3. Isin canal, deflected by levee barrier. 4. Parthian–Sassanian Uruk Canal. 5. Sediment fan from Sassanian field system, culminating in dune fields trending northwest–southeast, piling against and overtopping the levee—and in the process, scouring away lighter surface soils. ASTER 2003.

with the Larsa canal discussed on page 166. [66] Thereafter, it seems to have fallen out of use until the Parthian–Sassanian periods, when new (narrow, straight) canals were

[66] Running, as shown on Figure 57: 2 above (depicted by Adams 1981 and dated by Steinkeller 2001 to the Ur III period), from sites WS 175–83, to 190, 199, 200, 202, 204, 164, 163, 259,–61, 263, 294, 295, and 308–305. The patchier, more deflated

dug atop its (wide, decayed) levee (Figure 60). That the latest features have not been planed away by southeasterly-scouring dunes suggests actual abandonment during the intervening millennia, but establishing whether these third millennium sites are, in fact, associated with the watercourse itself, and that they therefore may be used to supply boundary dates for it, requires several steps.

A channel junction between sites WS161 (Early Uruk–Jemdet Nasr) and WS260 (Late Uruk–Early Dynastic) allows us first to examine the stratigraphy of sediments surrounding this structure. The tops of several smallish late-fourth—early third millennium mounds are visible, surrounded by sediments eroded from two decayed and deflated kilometer-wide levee systems, atop which later 50–100 meter-wide canals (for example, Figure 60: 4) have been excavated. Offtakes from these canals bypass or transect the sites, with no apparent connection to them. This suggests that the sites came into existence before the levees built up, but were exposed during the not inconsiderable re-engineering of the canal beds and offtakes.

Spatial analysis along all five of these watercourses shows a trimodal site grouping. Sites of all periods tended to be clustered (or to be most visible) especially at their head works near Nagsu; at mid-length branch junctions, and less so near their distributary tails (Figure 61). Apart from the differential exposure of sites in these locations, this suggests abiding durability of distribution points, as it is precisely their repeated re-excavation that multiplies opportunities for exposure of earlier deposits.

"old" levee (Figure 59), would appear to run from the vicinity of sites 200–204, via 220–222, 371, crossing the Larsa canal levee, through 311, 309, 314, 332, 331.

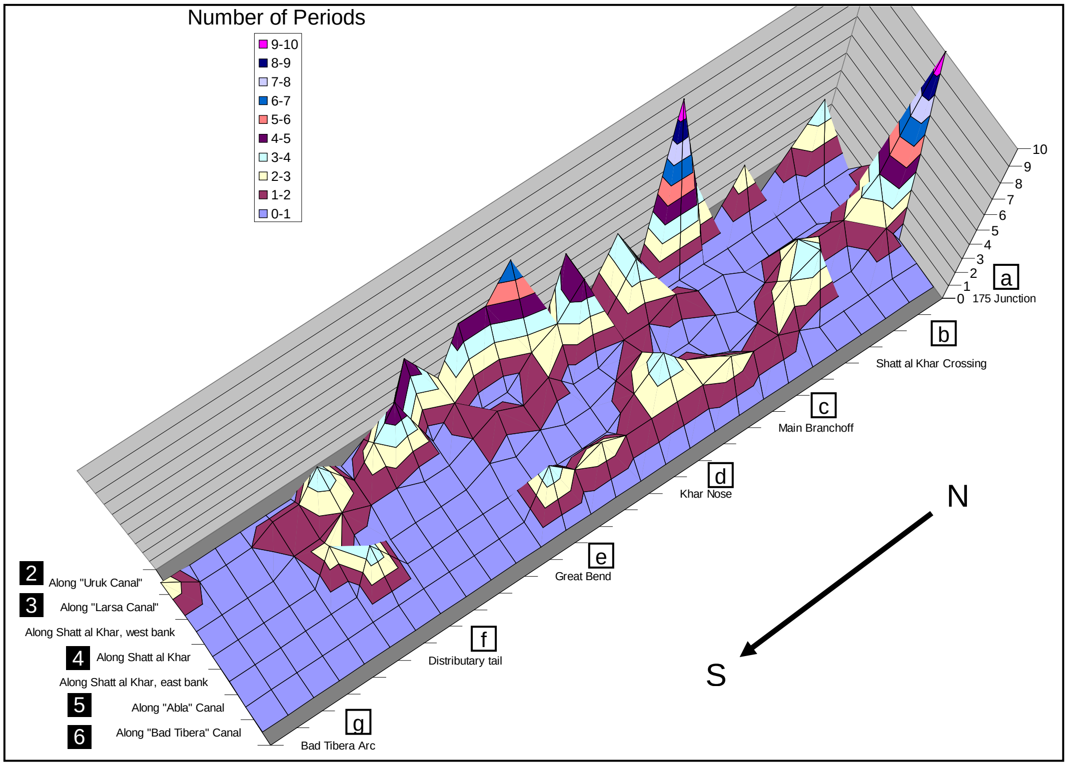

Figure 62: Is deflation uniform along watercourses? Clearly, no. This graph of the total number of periods during which sites are occupied, North to South, along major waterways shows increased visibility near, and/or high durability of, channel junctions. The predominance of visible sites of all periods along the "Uruk Canal" and west of the Shatt al-Khar also suggests greater deflation on the windward side of this westernmost levee (see Figure 60: 1, 5). However, mid-reaches of the "Abla canal" to the east of the Shatt al-Khar also appear to be exposed, as can be seen on Figure 55. Letters, numbers refer to Figure 57.

However, sites of the late fourth millennium BCE (Late Uruk—Jemdet Nasr) are most visible where located near sites of later periods—especially the much later Parthian–Sassanian periods—a strong indication that first millennium engineering has selectively enhanced their visibility (Figure 62).

This relationship is especially apparent when looking across the span of these watercourses from west to east. More sites, and more early sites, are visible along the Uruk and Larsa canals, west of the Shatt al-Khar, where old levees invited new uses,

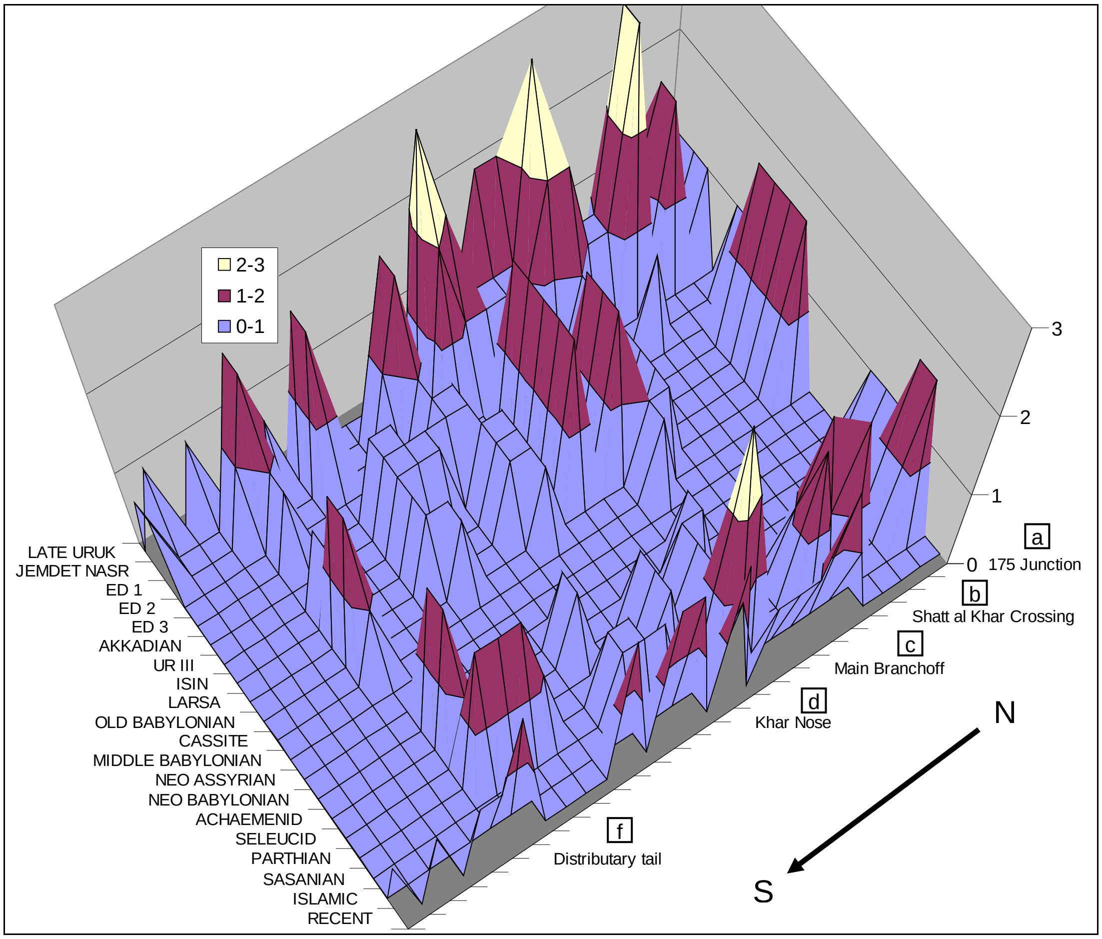

Figure 63: Is the Warka basin itself uniformly deflated? Again, no. This graph of the number of sites by period and latitude, north to south, shows that site visibility for all periods is prevalent to the north, but Uruk–Jemdet Nasr—Early Dynastic sites are most visible where extensive, more recent (Parthian–Sassanian or later) activity has disturbed soil surfaces. Letters refer to Figure 57.

and where the basin is most deeply deflated. East thereof, where irrigation has abated aeolian scour, canal offtakes from the Shatt al-Khar cast a large sedimentary shadow (Figure 63). Nevertheless—indeed, almost surprisingly—the early periods are well represented along the mid-reaches of the Abla canal (Figure 64),[67] suggesting that

[67] See Figure 57: 5; roughly WS 230–34, 368, 377–82, 401–03, 425, 432.

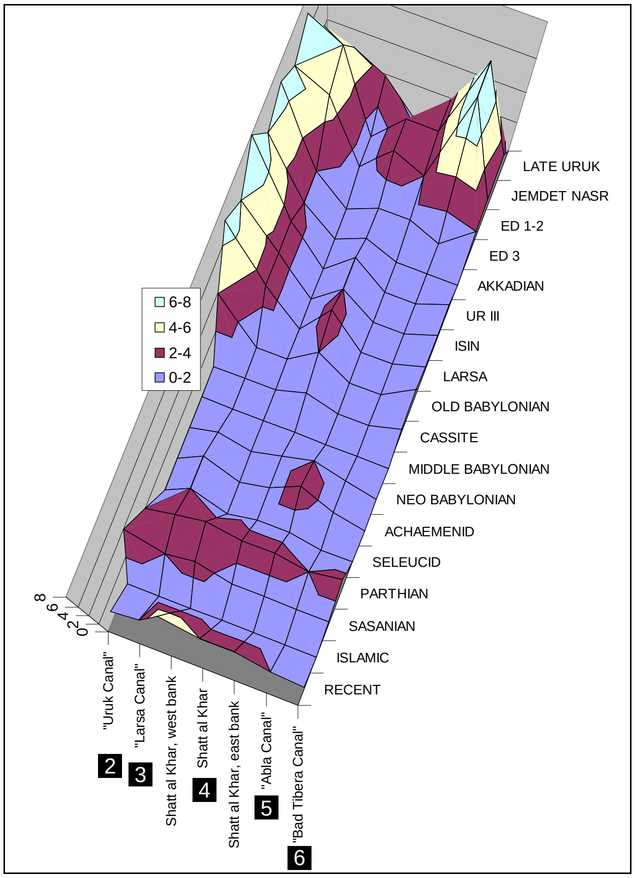

Figure 64: Number of sites along watercourses, by period, west to east. Earlier sites are most visible to the west, and especially so near later (especially Parthian–Sassanian) disturbance. The heavy sediments of the Shatt al-Khar levee itself mask much of its history. However, these waterways all appear to have been active during the mid-fourth–mid third millennium BCE. Thereafter, the Uruk and Larsa canals were maintained through the Old Babylonian period, but were abandoned for nearly a millennium thereafter. Numbers refer to Figure 57.

fragments of a third millennium watercourse may be preserved here. But what kind of watercourse?

Twenty-four Late Uruk period archaic economic texts recovered from Warka (Uruk IV, c. 3400–3100 BCE)—the earliest known economic records— mention recognizable place-names associated with three channels: with the Purrattum (Euphrates), is Uruk; with the Iturungal (“Eastern Euphrates,” or Tigris), are Adab, Umma, and Larsa; and with the Id-Nun (combining both), is Ur. (Nissen 1985: 230; Potts 1997: 29). By Jemdet Nasr–Early Dynastic I (Uruk III) (c. 3100–2900 BCE), the number of texts containing recognizable toponyms had increased six-fold, to 152 (Nissen 1985: 231). Kish, on the Euphrates in northern Babylonia was mentioned

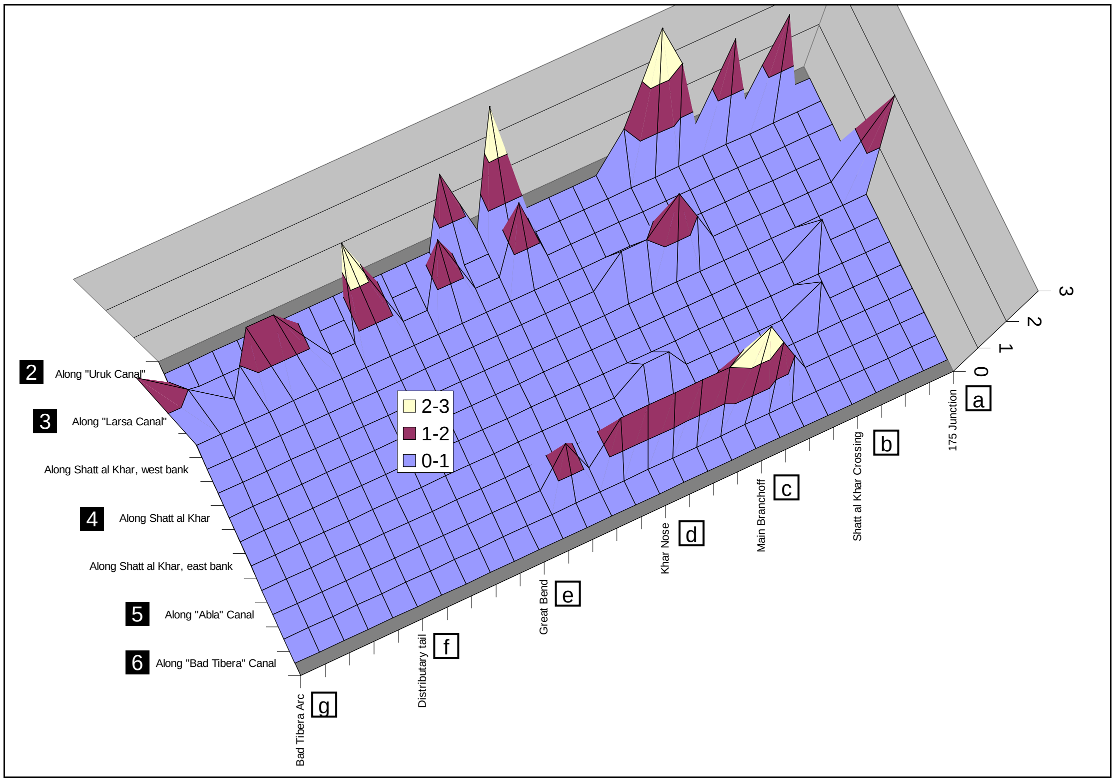

Figure 65: Late Uruk–Early Dynastic I sites, by watercourse. Sites are most visible along the northeast segment of the Uruk canal, southeast segment of the Larsa canal, and middle reach of the Abla canal. However, re-examine Figure 55, Figure 57, and Figure 60. Uruk and Jemdet Nasr sites "along" the Uruk and Larsa canals actually line up with the leading edge of basin deflation, not with the later watercourses that define that edge as they cross over the lower plain surface. These sites may demarcate the leading edge of a prograding delta, but only sites along the "Abla canal" seem to be associated with a waterway per se.

seven times, but Eshnunna, in the Diyala region, accessible by upstream travel along the Tigris, is mentioned only once. At this time, the majority of toponyms are associated with the lower reaches of the Purrattum and Iturungal. Most frequently mentioned of course were Uruk (x57) and its nearest neighbor to the north, on the Purrattum, Shurrupak (x31). Associated with the Iturungal, are Adab (x8), Zabalam (WS169) (x31), Umma (WS197) (x7), and Larsa (x2). Ur, to the southeast on the Id-nun (x14), and Dilmun (Bahrain) (x11) down the Persian Gulf are mentioned with nearly equal frequency. From the perspective of Uruk, fewer itinerary stops at Adab, Kish, and Eshnunna are, given their greater distances upstream, to be expected. The frequent mention of Shurrupak and Zabalam—points equidistant, as the crow flies, from Uruk—suggests easy navigation to those cities. But Umma is, in ground distance, nearer Uruk than is Zabalam. Why does it not figure more prominently?

Only one mapped levee system—that of the Shatt al-Khar, discussed above (page 92)—is of sufficient dimension to be a ready candidate for a major branch of the Tigris. It is also the only levee “connecting” the Late Uruk/Uruk IV Iturungal (Tigris) cities of Adab and Umma. But it does not connect them directly. Rather, branches fan southeastward from the main levee just southeast of Karkar, one of which passes to Umma via Zabalam (Figure 57). A second node of avulsion south of Nagsu gives rise to the old Larsa and Abla canal levees. This is a channel arrangement comparable to that of the Tigris today from just north of Amara to Qalat Salih, and although the actual bed of the fourth millennium “main” channel is probably buried, the exposed midsection of the Abla canal may well be the remnant of one of these side branches. The “Old” Iturungal (Uruk canal) discussed above (Figure 59) may be another.

Moreover, this interpretation implies a marshy basin through which these channels were actively building a delta—a reconstruction that accords well with the physical evidence for incursion, followed by withdrawal, of the Gulf 3600–3000 BCE, discussed on page 125. Further accord is seen in the progradation of site distributions southeastward through time. Note, in Figure 57, the predominance of Jemdet Nasr sites to the east and southeast, and, in Figure 22, the continuation of this trend in the

Early Dynastic. Note, also in Figure 57, the enduring cluster of sites in the northwestern corner of this basin, whence fans, not a unitary Euphrates, but three substantial levees. During the late fourth–early third millennium, rather than thinking of “the” Euphrates and “the” Tigris in this zone, we must consider the fate of several, smaller distributaries enroute to the sea. This would explain equal ease of transport from Uruk either to the north, to Shurrupak along the Euphrates, or to the northeast, transiting a watery realm through which what would become the Uruk canal lead upstream to Zabalam, and thence downstream to Umma—accounting for the fourfold mention of Zabalam as compared to that city.

Further support for this model of deltaic progradation comes from the lack of any clear connection between these waterways and those of the Eridu basin before the late third–early second millennium BCE (Figure 65).[68] Nevertheless, all four southeast-trending levees can perhaps be associated with sites as early as the Jemdet Nasr period. Of these, least clear is the route from Uruk to Ur. Either of the two best candidates passes to the south of Larsa (Figure 57, 2A and 3A), before joining the massive Ur levee near sites ES 68–70 and ES 63–67, respectively. (Figure 13, 4). The anastomosing channel 2A would seem to be the precursor to the consolidated levee emerging from the “Ur gate” at Warka, known from later texts to have been in use

[68] One might assume that the present-day Euphrates course would have scoured away or buried any such evidence, but sediment plumes and lines of tells, visible in flood-season CORONA images, throw up multiple levees in sharp relief. Interpreting and dating these, however, is complicated by lack of geological or archaeological survey within the active floodplain.

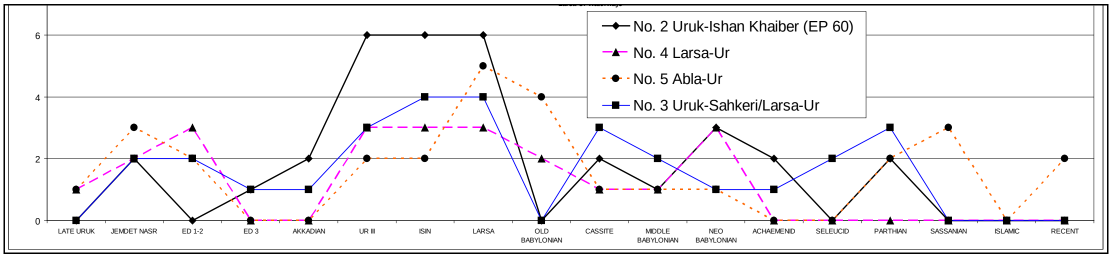

Figure 66: Number of sites along Uruk/Larsa–Ur waterways, by period.

during the Ur III dynasty (Figure 24, Figure 76). A third route trends indistinctly from, perhaps, Larsa to Ur via Sakheri Sughir (ES47) (Figure 57, 4A). The clearest joins Abla to Ur via Diqdiqa (ES11) (Figure 57, 5A).

These water*ways*, in the sense of routinely transited routes, need not be interpreted as water*courses*, in the sense of banked channels extending through arid zones. Initially, they probably represent routinized boat transport routes, perhaps with villages along their banks, kept clear of reeds during wet seasons and channeling water during dry. Such village distributions are visible throughout the modern Awhar, for example in the Euphrates delta near Kabaish (ech-Chubayish) (Roux 1960: 36; Salim 1962), or the Tigris delta at Suwaich, southeast of Qalat Salih (Figure 66) and Turaba–Abu Dakar, in al-Khuraib marsh east of Qalat Salih (Westphal-Hellbusch 1962: 54 f.) (Figure 67). This multiplicity of south–southeast trending third–second millennium channels, draining the Warka–Umma basin before finally coalescing into a joint levee, is further evidence for a littoral interface. Indeed, it may one day prove to account for some of the *unidentifiable* toponyms in the texts discussed above. It would appear, for example, that Umma had its own direct access to Ur by one route (via marshes, WS230, and Abla), and to the sea by another (via Lagash). Uruk lay nearer the retreating coastline, and nearer the emerging combined outflow now mostly buried,

Figure 67: Suwaich, extending several kilometers along a waterway. Top: in the deep marshes south of Qalat Salih, only bright white spots are above the water surface. CORONA May 1968. Bottom: after marsh desiccation, (erroneously) appearing to be a chain of small settlements strung along a canal. LANDSAT 1994. See Figure 80.

but partly exposed along the southern edge of the modern Euphrates enroute to Ur.

Broadly speaking, three urban zones frame the surveyed portions of the Eridu basin south of the Euphrates (Figure 51: I): the temple complex at Eridu, the excavated port city of Ur, and ES34, an Isin-Larsa-Old Babylonian city. More precisely, Wright's survey of the basin was circumscribed by a remarkably well-preserved levee topped with meander scrolls and channel bars etched in sharp relief, into one bend of which ES34 seems tucked away (Wright 1981) (Figure 68). Clearly, this levee has a complicated history, as does the basin through which it wends. Pocketed with wadi sediments washed down from its ringing escarpment (Figure 11); scoured and layered with sands blown down from the Arabian shield (Figure 8); alternately flooded by

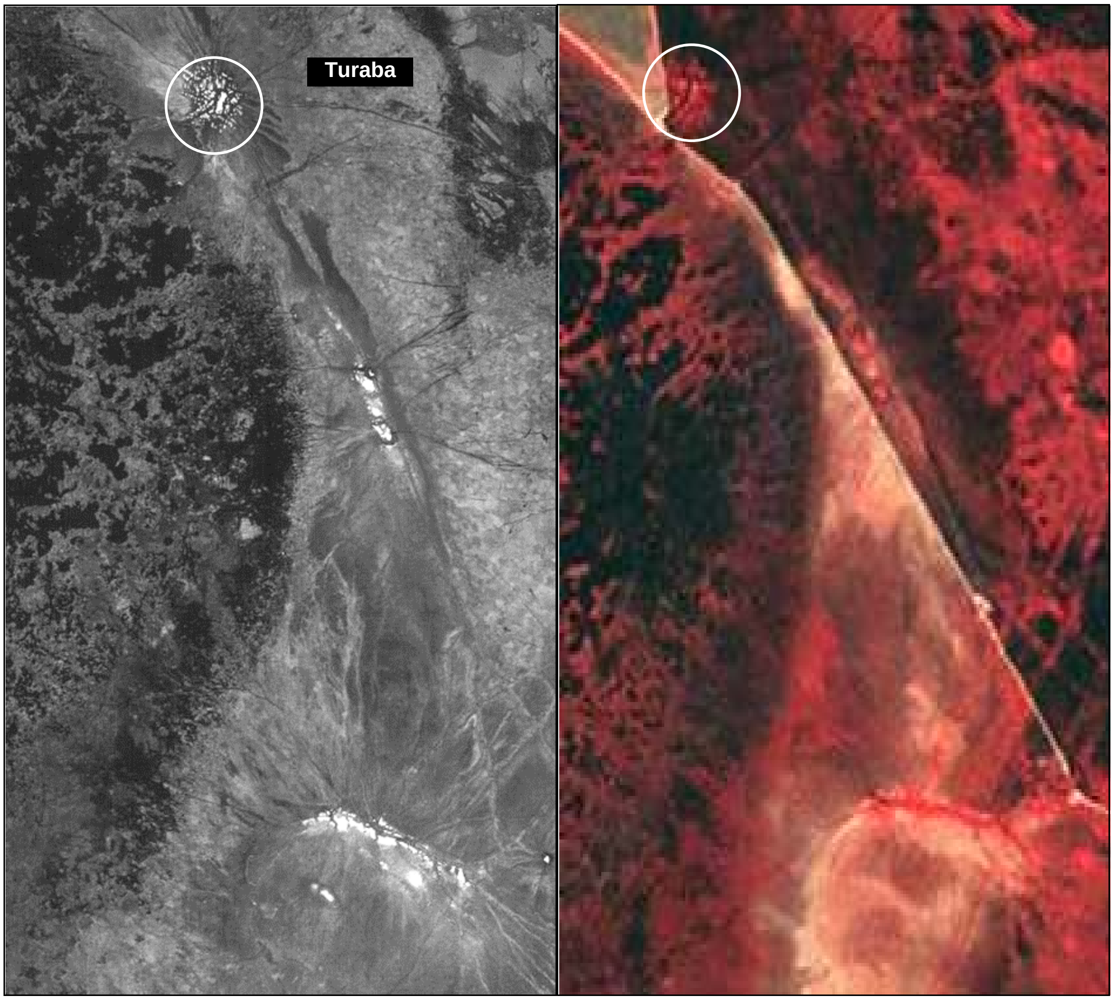

Figure 68: Turaba–Abu Dakar, in al-Khuraib marsh east of Qalat Salih. The former waterway through deep marsh, intersected by boat paths through reed beds, has been embanked as a permanent drain, leaving settlements stranded.
(L) CORONA, May 1968. (R) LANDSAT 1994.

winter rains (Figure 12), and parched by summer sun, the Eridu basin comprises a complicated patchwork of new sediments, old surfaces, and migrating dunes. Southeast of ES34 beside the fragments of older sediments, lies ES156, a city that appears to have prospered during the early third millennium (Figure 69). On the mound itself, surface survey turned up Jemdet Nasr–Early Dynastic material, while surrounding lands were littered with flint sickles, presumed to have been used for

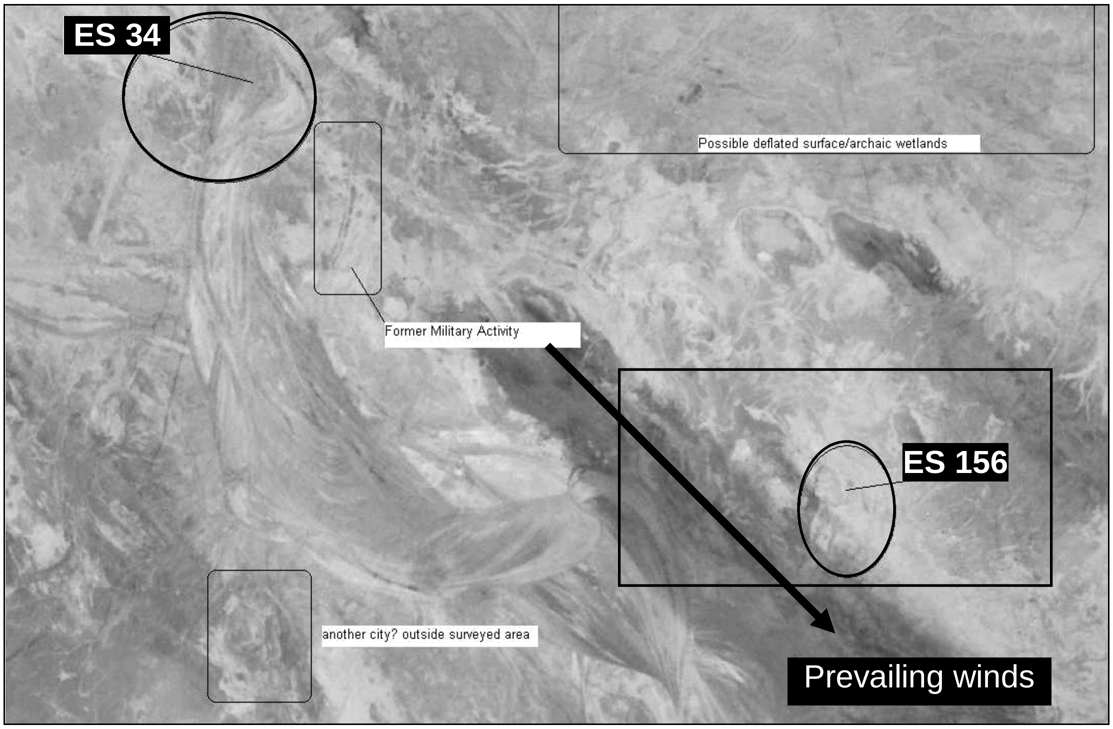

Figure 69: The Eridu Survey area’s western margin (SPOT 1991). Boxed: Figure 69.

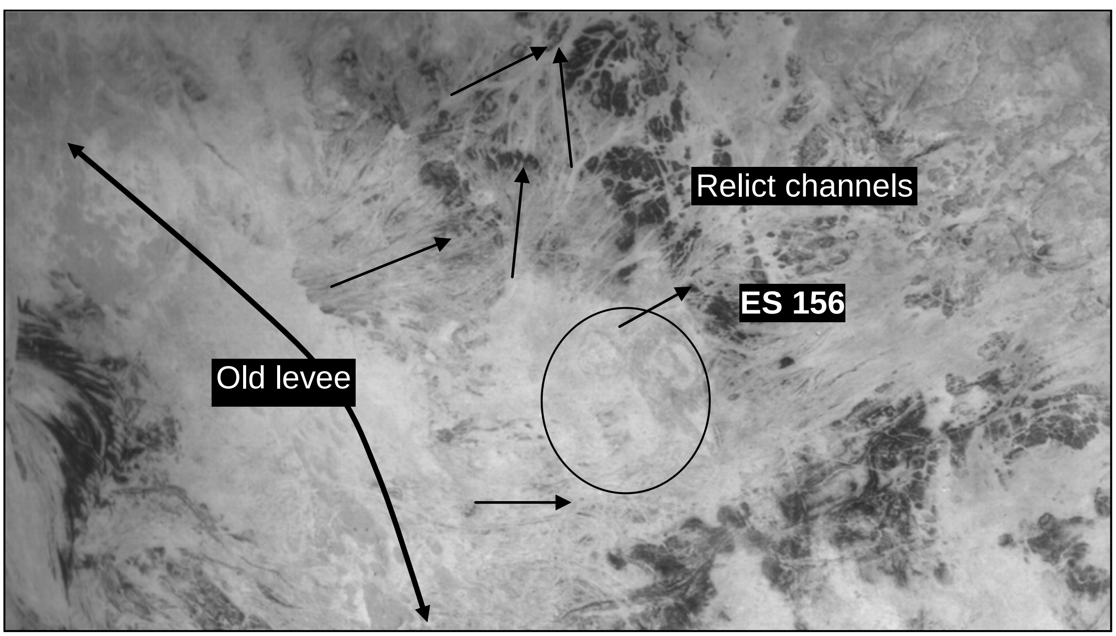

Figure 70: Hundreds of thread-like channels, 1.5–10 meters wide, extend between ES156 and surrounding desiccated wetlands, suggesting levee cultivation combined with intensive marshland exploitation, as in Figure 72. CORONA May 1968.

grain harvesting. Yet the configuration of this city’s hinterlands does not suggest

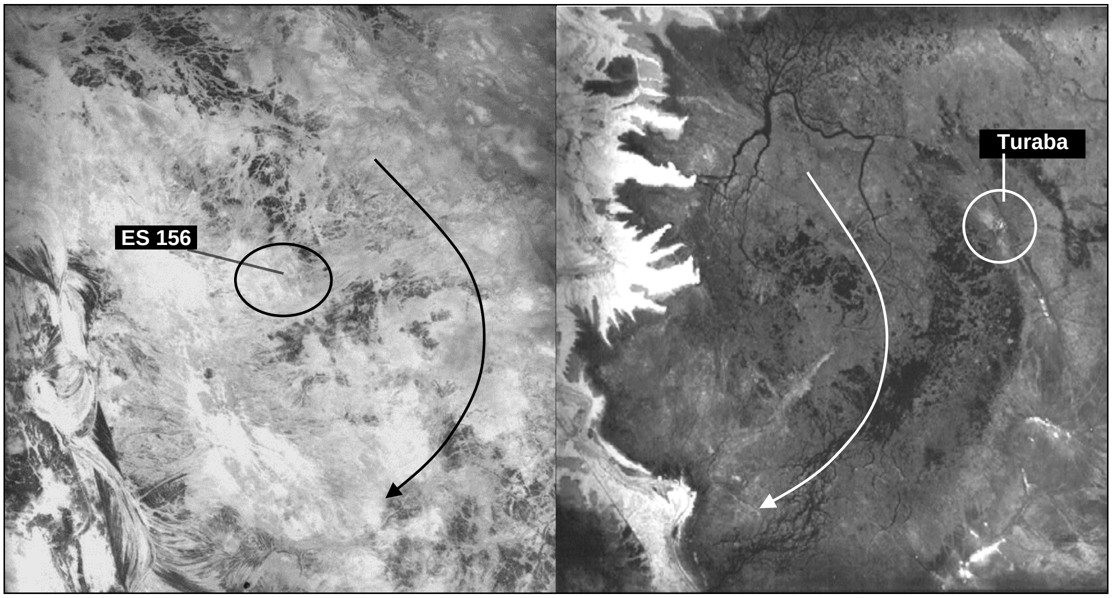

Figure 71: Marshland hinterlands. (L) ES156 in the Eridu Basin. (R) Abu Dakar in the al-Khuraib (Tigris) marshes south of Amara. Water overtops banks and leaks through weak levees, draining slowly to eventually rejoin the fluvial system (arrows).

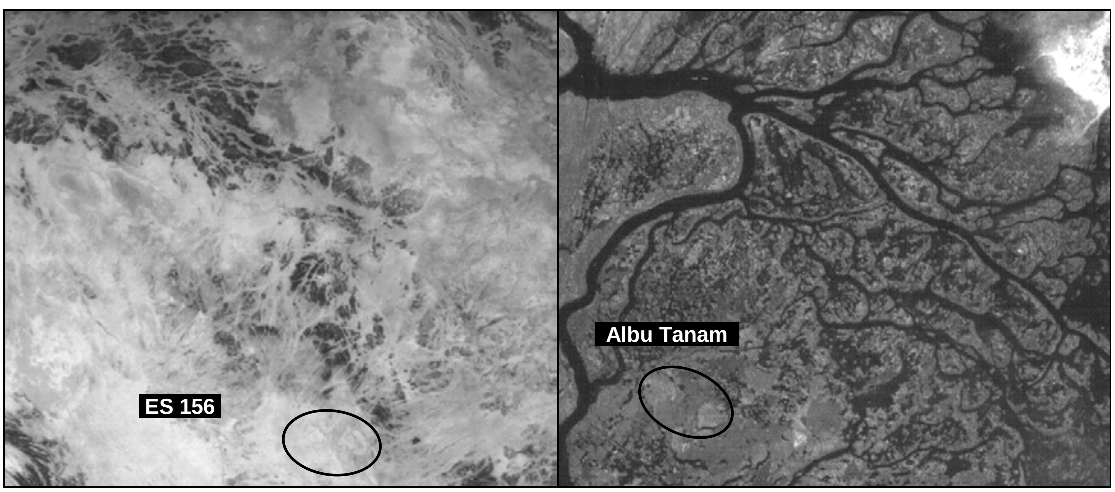

Figure 72: (L) Desiccated (white) water channels infilled with dry sand skirt EP156. (R) Dendritic water channels (black) through reed beds skirt Abu Tanam.

anything like the regularity of plowed fields, nor communities dependent upon the civilizing influence of irrigated cultivation. Rather, the surrounding geography suggests the marshy basin setting of Turaba–Abu Dakar in the al-Khuraib (East Tigris) marshes, with water that floods over and seeps through weak levees, slowly draining southward to eventually rejoin the fluvial system (Figure 70). [69] Closer views bolster this impression of former dendritic water channels infilled with dry sand (Figure 71). At very high resolution (Figure 72), it suggests waterways connecting marshland towns to the clusters of houses and byres built by wetland cattle-keepers who harvest thousands of tons of reeds and rushes for mat-weaving, fodder, fuel, and construction material to meet both local need, and those of urban brokers on the marsh fringes, discussed in Chapter Five (Salim 1962, Westphal-Hellbusch 1962). No excavations have been conducted here, but at nearby Sakheri Sughir, *Phragmites* phytoliths have been recovered from contexts suggesting the use of this reed as fodder during the Early Dynastic I period (Miller-Rosen and Weiner, 1994, Miller-Rosen 1995 and personal communication 2003).

This remarkable congruence may be direct evidence that this surface has

Figure 73: (L) Cattle-keeping marsh settlements of the Euphrates delta (Nik Wheeler, 1974, in Partow 2001). (R) Relict landscape near ES156 (CORONA 1968).

[69] While these marshlands no longer exist, endless repetition of the phrase “until the close of the past decade” is needlessly tedious. Unless otherwise noted, I adopt a historical present of 1968–69, the year documented by CORONA photographs used.

indeed become deflated to at least Early Dynastic levels. And coupled with the physical evidence discussed above—sediment cores, patterns of salinization, the location and nature of relict water courses and shorelines—it demands a close re-evaluation of archeological evidence obtained by excavation, to which I now turn.

C. Visible Settlements[70]

To this point, I have attempted to show compelling cause for abandoning a pearls-on-a-string model for associating early settlements with unitary watercourses in the Mesopotamian delta lands. I will now attempt to demonstrate that there are other terrain features in this setting more relevant to the genesis of urban centers and their hinterlands. Herein I argue that early cities—at least, those cities that lived long enough to tell the tale—grew up on what to our eyes would be barely perceptible as high ground, while their supporting agricultural hamlets fanned out around flood basins and forward onto the prograding toes of deltaic fans.

During the pluvial end-late Pleistocene Würm marine regression, rivers scoured channels of up to forty meters deep, leaving terraces (at former plain-level) protruding above the water surface and dumping scoured sediments at delta mouths, as seen today at Bubiyan Island at the modern head of the Persian Gulf (Sanlaville 2003: 140) (Figure 73). Valleys between these terraces were infilled with subsequent

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[70] For the following discussion, I follow Nissen's ceramic seriation (Adams and Nissen 1972), and the Porada, Hansen, Dunham, and Babcock 1992 chronology as updated for Mesopotamia by Valladas, Evin, et al. (1996), and Wright and Rupley (2001). Reseriation based on 'Oueili finds will revise the Nissen ceramic chronology, but such adjustments will not substantially alter the conclusions made here.

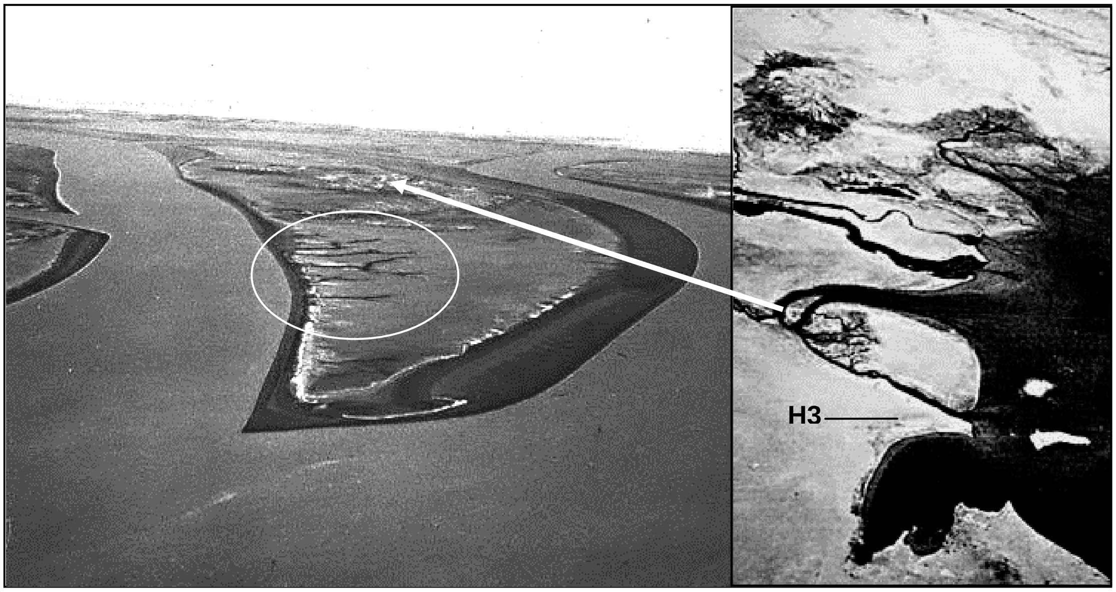

Figure 74: Bubiyan Island (Kuwait), at the head of the Persian Gulf. Photos: Coleman, Roberts, and Huh 1986.

colluvium and alluvial silts, leaving the impression of a uniform plain. However, during mid-Holocene flood seasons, the tops of these relict terraces and sediment dumps, being of slightly higher elevation, would have remained dry, while the surrounding plain became inundated by sheets of floodwater—like turtle's backs protruding from a silty tidal flat. When imaged with high resolution cameras during the spring spate, when floodwaters saturate lower-lying ground, they can be identified by drainage and differential dampening at their bases, making their slight relief above plain level detectable even without detailed elevation data (Coleman, Roberts, and Huh 1986). This can be readily seen in a 1968 image of Tello (ancient Girsu), where archaic city walls encompass one-third of a turtleback's land area (Figure 74A). Within the Warka survey area, situated on a pronounced turtleback, the linear array of site WS230 along internal canals, no doubt maintained to allow untrammeled boat access to surrounding marshes, is equally visible (Figure 74B). Site WS298, a low mound located about ten kilometers northeast of Uruk, is similarly situated, facing a levee back slope. As noted for Tell ‘Oueili (page 160) (WS460), where Pleistocene buttes punctuate a Holocene surface incised to several meters depth by the Shatt al-Khar, east of the site (Huot 1989, 1991, 1996; Forest 1996), the elevation of mounds and relict landforms exposes their surfaces to the scouring effects of windblown sand.

Excavations there show an underlying geomorphology analogous to similar sites in the Nile delta: the settlement mound is situated atop a low, buried turtleback, where it was most likely located for protection from seasonal flooding. A deep

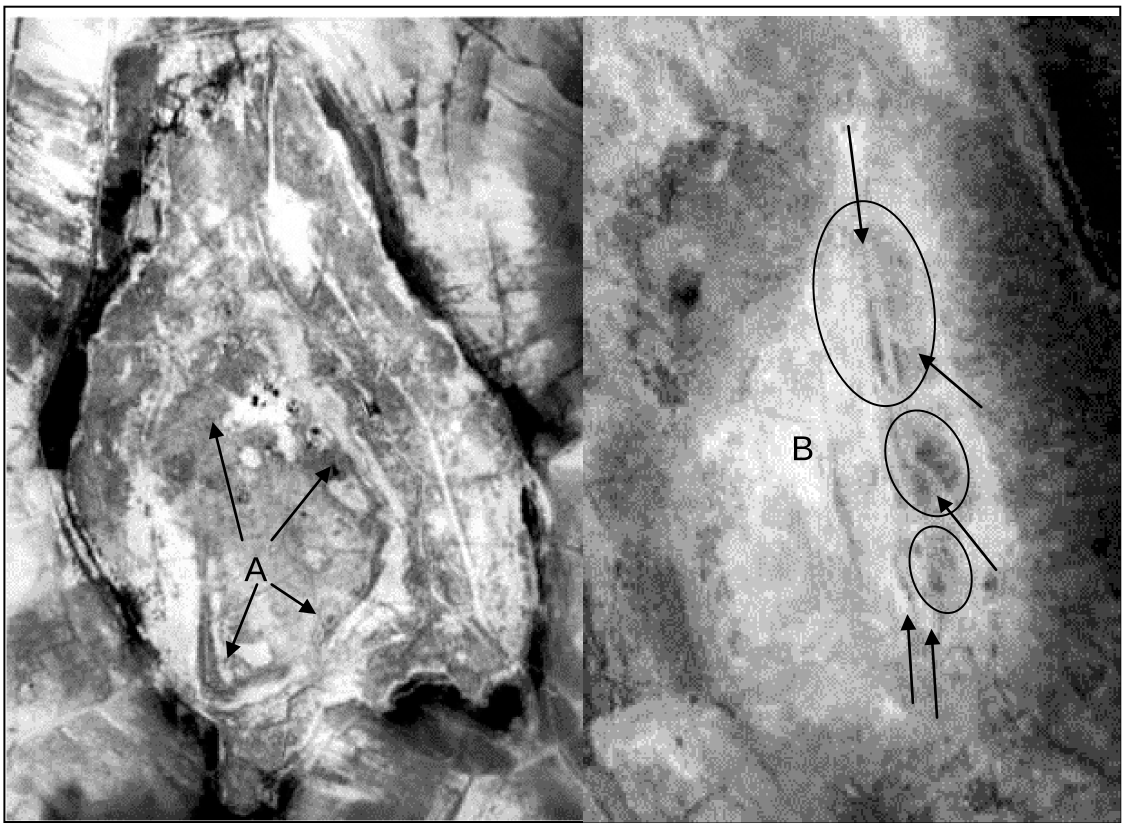

Figure 75: (A) Tello (ancient Girsu) appears to float on an island within irrigated croplands. The archaic city walls (arrows) encompass one-third of the turtleback. (B) Sites WS230–232, arrayed along internal canals (arrows) within a turtleback. The high water table following spring floods damps dust and reveals fine details of relief invisible at other seasons. CORONA KH4B_1103-1A-D041-057 (May 1968)

sounding showed four meters of alluvial deposition surrounding and eventually burying the channels that would have carried waters past its sixth millennium BCE ('Ubaid 0) foundations (Porada, Hansen, Dunham, and Babcock 1992: 86; Plaziat and Sanlaville 1991). Among botanical finds were edible sedge tuber fragments (*Cyperus rotundus*) and stem imprints of giant reed (*Phragmites australis*) (Neef 1989), both suggesting that fresh water pooled near the site. That this was not merely a local phenomenon is shown at borehole B, where an ancient marsh was swamped by marine incursion during the remainder of the fifth millennium (Figure 31, Figure 75).

'Ubaid 0–1

Such excavation evidence, coupled with surface survey, indicates a long period of adaptation to littoral conditions. Since surface surveys were conducted prior to the 'Oueili excavations that added "Ubaid 0" to the typology, no surface finds were dated to that period (6500–5900 BCE). But the deep sounding at Tell 'Oueili (WS460), characterized even at this early date by extensive mud-brick construction, showed five meters of 'Ubaid 0 material remaining above the water table at two meters above sea level (Calvet 1983: 15), including at a depth of four meters cigar-shaped bricks and pottery in style and assemblage closely related to Choga Mami Transitional ware from central, eastern, and northern Mesopotamia (Valladas, Evin, and Arnold 1996: 383; Porada, Hansen, Dunham, and Babcock 1992: 86; Oates 1987) (Figure 75). [71]

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[71] Central: Tel as Sawwan, 6425–5560 BCE. Northern: Choga Mami, 6036–5480 BCE. See note 11. All dates calibrated ^{14}C. 'Oueili: shell; Sawwan, Choga Mami: tree charcoal (Valladas, Evin, and Arnold 1996: 383).

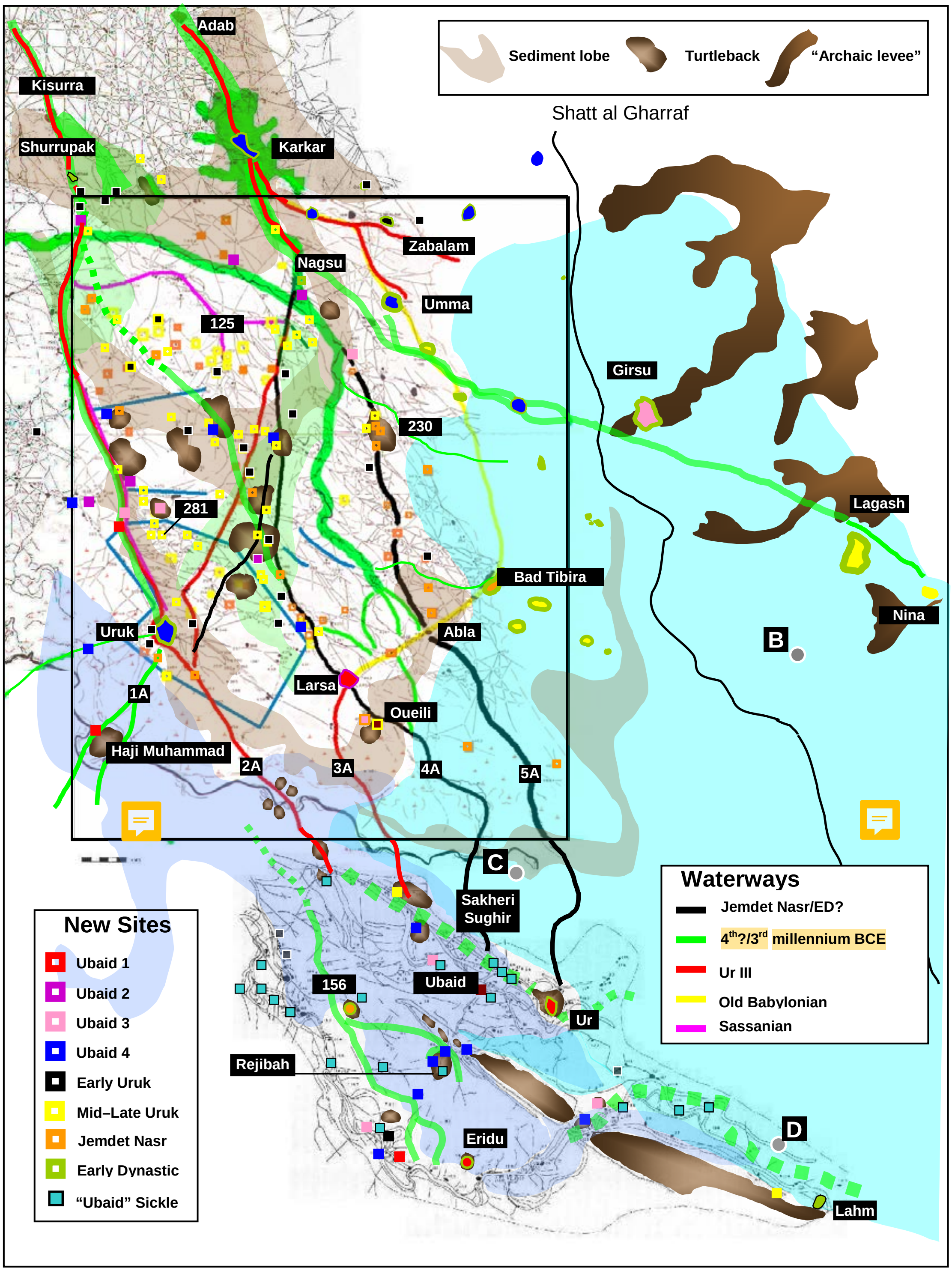

Figure 76: Sites of the 5th–3rd millennium BCE delta, with marine incursion and mixing zone. Borings show: at (B), a transition from fresh marsh to brackish marine conditions 'Ubaid 1-4; at (C) and (D), brackish marine 'Ubaid 1–Middle Uruk, followed by brackish marsh Late Uruk–Ur III and salt panne thereafter. This area comprised an outer delta, as at Figure 29. Boxed: see Figure 20, Figure 57.

Within the Warka survey area, two ‘Ubaid 1 (“Eridu Phase,” 5900–5200 BCE) sites were aligned north-to-south along the Euphrates distributary dissipating into wetlands south of Uruk (Figure 75, 1A),[72] and surface pottery of this period suggests an early occupation at Larsa, that would have bordered marshes fed by the great Tigris distributary running southwards from Karkar (Figure 75, 3A) (Lebeau 1989: 17–118). South of the present-day Euphrates, Ur’s foundations mounted a sandy butte bordering what was, or would become, a massive levee system, and near Ur, Tell al-Ubaid (ES8), was founded on a low sand knoll (Hall 1930, Hall and Woolley 1927). The brackish marine conditions indicated at boreholes C and D, which persist until the mid-fourth millennium (Middle Uruk), suggest that these sites hugged the shoreline near freshwater outflow. However, comparison of “Haji Muhammad Phase” pottery at Tell al-Ubaid (Hall 1930) to ‘Ubaid 0 type ware (Huot 1996) shows clearly the need for reseriation and reconstruction of early occupations, and as Oates (1960) has long noted, the possibility of a much earlier origin for these sites. Eridu, founded on consolidated dune material, straddled tails of what may have been a Euphrates mouth. Pilastered mud structures predated a succession of temples with burnt offerings of fish (Safar, Mustafa, and Lloyd 1981; Porada, Hansen, Dunham, and Babcock 1992), as well as a canoe model and numerous perforated clay ovoids—perhaps net weights (Lloyd and Safar 1948, 118, Pl. III)—suggesting “that the marshes were already being used in a sophisticated manner” (Wright 1981: 323). Safar also noted freshwater

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[72] W 267, and Haji Mohammed, which flourished as the ‘Ubaid 2 type site.

mollusk shell at nearby ‘Usailia (ES104); Wright confirmed this observation, noting that the shell was eroding from earlier (‘Ubaid 2 at he latest) levels of the site (Wright personal communication 2003).

‘UBAID 2

By ‘Ubaid 2 (“Haji Muhammad Phase,” 5200–5100 BCE), three sites were exposed along the rim of the deflated Parthian field system radiating from Uruk, and three more along the southeast-trending levee of the Shatt al-Khar connecting the Euphrates and Tigris south of Shurrupak and Nagsu.[73] One site overlooked (undated) westerly marshes, near the first of what would become a complex of sites characterized by surface finds of spools and net weights.[74] In the twentieth century marsh districts near al-Hiba (Lagash), characterized by a mixed agro-pastoral-fishing-reed manufacturing economy, similar spools and weights were employed in spinning yarn and weighting fishing and fowling nets (Ochsenschlager 1993b). A low mound located approximately ten kilometers northeast of Uruk was situated on a turtleback facing a levee back slope.

[73] WS42, WS51, and WS178, near the Nagsu junction.

[74] WS247, WS242. This area has repeatedly flooded, most recently during the nineteenth and twentieth centuries, and remains unsurveyed, rendering dating of the marsh zone difficult at best without sediment sampling (Potts 1997: 39). However, as the prevailing geosyncline (Buday and Jassim 1987) would have tended to pool floodwaters predominantly west and south of the Uruk distributary—a process apparent along lower Tigris distributaries until the mid 1990s—associated, repetitive marshland formation in this zone was exceedingly likely.

‘UBAID 3

Ubaid 3 (5100–4900 BCE) surface finds were noted at two sites near Uruk, one on a turtleback and the other one the Euphrates levee north of the city,[75] and although ‘Oueili itself appears to have undergone an occupation hiatus, Tell al-Tawwil (WS459) appeared adjacent to it. A fourth site continued the ‘Ubaid 3 line extending toward WS230, trending in the direction of the earliest remains at what would become Girsu (Figure 75, 5A). South of the modern Euphrates, late ‘Ubaid 3 site ES141, sporting concentrations of freshwater mollusk, joined the Tell ‘Ubaid on the Ur levee. A second site (ES96) perched on the basin rim. ES29 occupied a sand knoll at a passage through a sandstone finger (“the Hazim”) that probably prevented sea water flooding the Eridu basin. The passage probably served as an outlet draining the basin’s freshwater wetlands; a freshwater lake may have pooled in the low-lying ground around Eridu itself. By the second millennium this passage provided outflow for the Euphrates flow that bounded the Eridu Survey Area (Figure 25). The Eridu basin is at this time characterized by an “expansion of settled areas up and down the developing levee system” (Wright 1981: 323),[76] dated as such by the presence of fired clay sickles. Wear pattern, embedded chlorophyll, and phytolith analyses of similar sickles at ‘Oueili–where attempts to experimentally re-create microscopic wear striations that would have resulted from grain harvesting failed—make intensive reed-harvesting an

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[75] WS275, WS267.

[76] ES36, ES38, ES51, ES55, ES70, ES79, ES83, ES89, ES90, ES93, ES94, ES97, ES142, ES148, ES156, ES161, ES162, ES165.

equally likely use (Anderson-Gerfaud 1983: 177–91; Benco 1992: 119–34). At Eridu, temple platforms were raised, and clear evidence of mud brick directly associated with adjacent reed domestic construction was exposed (Safar 1950: 28) even as a flourit of Mesopotamian-manufactured (imported) pottery appeared at Gulf coast sites.

Consistent with a reconstructed shoreline skirting the Hazim and Ur levee, pottery and other evidence that the ‘Ubaid 2–3 emphasis on levee colonization was directly tied to coastal water travel is suggested by Mesopotamian-manufactured ‘Ubaid-period pottery found among the deep shell middens bordering Kuwait, discussed in Chapter Three (page 115) (Beech, Elders and Shepherd 2000, British Archaeological Expedition to Kuwait 2002, Carter and Crawford 2001, Carter et al. 1999, Roaf 1996, Freifelt 1989, Oates 1978). While most common at Ur (Porada, Hansen, Dunham, and Babcock 1992: 86), the ‘Ubaid 2 style was

> the first to occur in sites along and behind the Saudi Arabian shoreline, more than 600 kilometers southeast of Eridu…[C]hemical analyses indicate that the painted pottery there was of southern Mesopotamian manufacture, implying periodic visits by fishermen from settlements along the Tigris-Euphrates delta… (Oates 1976: 22; Oates, Davidson, Kamilli, and McKerrel 1977).

‘UBAID 4–TERMINAL ‘UBAID

The long-lived fifth millennium BCE ‘Ubaid 4/Terminal ‘Ubaid (4900–4200 BCE) adds to this settlement trend. Karkar, Umma, and four sites in the East Gharraf area fan out from the Tigris avulsive node into the hypothetical northeastern margin of the mixing zone. Surface finds show four new sites on turtlebacks or abutting levee back slopes in the Uruk basin.[77] One (Raidu Sharqi) is added to a delta toe southwest of Uruk. At ‘Oueili, added to the earlier wetland botanical constellation of tubers and reeds are cultivated date palm (*Phoenix dactylifera),* water-loving poplar (*Populus euphratica*) and halophytic sea club-rush (*Scirpus maritimus),* with a continuing faunal emphasis on cattle and pig (Neef 1989). Date cultivation in particular suggests associated gardens and the need for mechanisms determining access to and control of the turtleback, which was probably surrounded by salt marsh.

Thus far, at Uruk itself, ‘Ubaid 4 is the oldest period reached beneath the tens of meters of overburden straddling the multiple levees of its bird’s-foot delta. In 2002, the Deutsches Archäologisches Institut Berlin made thirteen borings in and around the mound, of which eight penetrated to depths of up to three meters below mean sea level (Figure 76). [78] Eight of these showed marshy deposits at 1.5 meters above present sea level; in one core, ‘Ubaid materials were found imbedded in this layer. Above this, approximately six meters of marshy and fluvial deposits were intermixed with what appeared to be Uruk cultural materials (Margarete van Ess, and Jörg Fassbinder, personal communication 2002; Brückner 2003).

In the south, seven new sites ringed the Eridu depression on sandy knolls and

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[77] WS137, WS160, WS218 (including spools), WS245, and WS411.

[78] Corresponding in the case of one to Eanna Deep Sounding VIII /*Tiefschnitt* Profile 4, levels 124–127 (Nöldeke, Heinrich, Lenzen, and Haller 1932: 6–8, Table 2; Eichman 1989: 197).

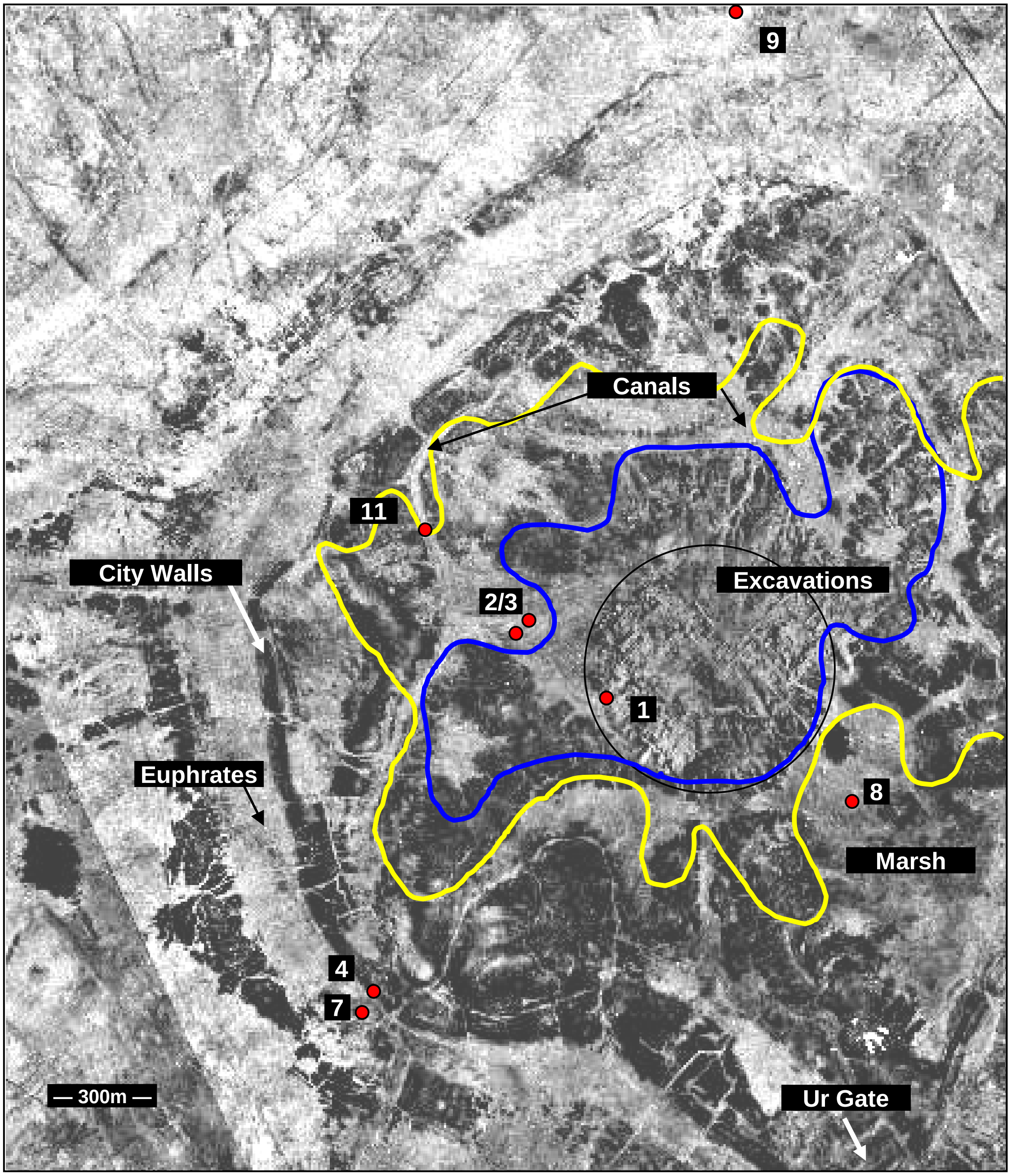

Figure 77: Warka (Uruk). Outlined: Approximate limits of occupation for the ‘Ubaid (blue) and Uruk (yellow) periods. By Early Dynastic 1, most of the area inside the city walls was inhabited (Finkbeiner 1991: inserts 22–24). The German Archaeological Institute’s numbered cores were augured from (top to bottom of frame): 9. Levee leading into the North Gate; 11. Old Babylonian canal; 2/3. Inside/outside canal descending mound; 1. High mound, Eanna precinct; 8. Marshy lowland;. 4. City Wall; 7. Euphrates bed (moat) outside the water gate. See also Figure 24.

turtlebacks, while another was added to the Ur levee.[79] Eridu, 12 hectares in extent, sported a temple on a raised terrace and, in an external cemetery, some individuals had substantial brick-lined tombs. Boat models indicate that sailing craft had been developed, quantities of presumeably Gulf-caught "marine" fish (species not identified)were recovered in the temple precinct and from the alter (presumably laid as offerings), and botanical remains also included dates (Safar 1950; Gillet 1981; Safar et al. 1981; Wright 1981). Similarly, Ur and al-Ubaid had grown to about ten hectares in size (Hall 1930, Safar, Mustafa and Lloyd 1981), while clay sickle distribution indicates extensive harvesting along levee back slopes (Wright 1981) (Figure 75).

During the 'Ubaid periods, as sea levels slowly rose from 15 meters below to within several meters of their current levels (Sanlaville 1989, Aqrawi 2001), mid-Holocene (6000/5500–3500 BCE) monsoon variations brought increased rainfall to the lower alluvium (el-Moslimany 1994; see Potts 1997 Chapter 1 and 52 *passim*). These conditions would have increased the likelihood of seasonal flooding and marsh formation in the Eridu basin. Such evidence as exists from coring, excavation stratigraphies, and stratigraphic profiles drawn from regional wells (Geyer and Sanlaville 1996), uniformly show marshy deposits underlying and/or mixed with earliest (Ubaid) occupation layers, suggesting that settlements were bordering on and/or subject to seasonal inundation.

While the Eridu basin does not appear to have been flooded with sea water, at

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[79] Ur levee: ES60; Rejibah turtleback: ES05, ES07; Hazim: ES 92; basin south rim: ES98; sand knoll at the Hazim egress: ES134.

Uruk, Hajji Mohamed, al-Ubaid, Ur, and Eridu, in addition to mud brick, the deepest soundings all revealed remains of reed platforms, traces of reed structures with plastered reed walls, and reed matting plastered with dung, earth, or bitumen (summarized in Moorey 1994, 361), suggesting the proximity of freshwater marshes. It has long been repeated (after Woolley) that early building techniques in the south comprised little more than “primitive” reed “huts”—a prejudice against this construction material that will be more fully explored in Chapter Five—although Woolley himself records contemporaneous mud-brick structures.[80]

Indeed, there is utter discord between Woolley's oft-cited verbal characterization and the rather massive reed-reinforced *pisé* columns and palisades that he depicted in his reconstruction—which he himself held to be the precursor of Mesopotamian half-column architectural embellishment (Woolley 1981: fig. 7). Ethno-archaeological photographs taken near Warka record reinforcement walls built in a similar manner along irrigation banks to prevent irrigation water from flooding into household compounds. The vertical reeds set initially into soft ground act as a “rebar” to anchor the mud-plastered structures. In some cases, this is also used as a facing for wider mud brick constructions, including both compound and house walls (Margarete van Ess, personal collection # 143, Deutsches Archäologisches Institut, Berlin). The ‘Ubaid 0 buildings at ‘Oueili employ partially molded mud brick extensively in elaborate constructions, such as the “hypostyle” buildings. Early sites

[80] The Ur excavation “flood pit” and “hut sounding” (Safar, Mustafa, and Lloyd: 47, 58) corresponding to profiles F, K, L, W–Z (Woolley 1933: 328, 334–336, plates 39, 42; Woolley 1956: plates 76–78, 82, 83).

must have been complicated compounds, composed of a combination of mud brick and pisé construction, reinforced with, added on to, roofed, and floored with a variety of reed poles, bundles, and matting—in some cases bitumen-coated to combat moisture.[81]

Inhabitants of the southern alluvium were apparently dependent not only on the better-studied agro-pastoral products, but upon liberal access to littoral plants and animals for food (tubers, fish, shellfish, fowl),[82] construction material (reed, riparian woods),[83] fodder and browse (reeds, sedges, salt grasses), and water supplies and

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[81] Those insufficiently attentive to Woolley's original text may or may not be forgiven for characterizing this as "primitive," but travelers through the 1970s have confused temporary, seasonal, purpose-built reed shelters for permanent dwellings—and thus tended to conflate these miscomprehensions with unsettled, backward, impoverished, simple, or remote economic organization.

[82] Pollock (1999: 83) summarizes 'Ubaid-period faunal evidence. The best-studied remains of fish are at el-Oueili (Desse 1983), where pig also accounted for 37%, cattle 49%, but sheep/goat only 5% of the faunal assemblage; and at Eridu, where (unfortunately neither identified by species nor quantified) masses of fish remains are associated with the so-called altar of the temple sequence (Safar 1950; Safar, Mustafa, et al. 1981).

[83] *Phragmites* and *Arundo* are both invasive commensals, adapted to millennia of exploitation for construction, matting, fodder, fuel, and flour manufactured from their tubers (Salim 1962, Thesiger 1964, Ochsenschlager 1993a). Both resist extermination by cutting, burning, or uprooting. Potts counters the pervasive idea that riparian softwoods were sparse and of little economic or construction utility—an idea probably related to over-concern with exotic beams imported to meet the demand for massive roof supports in (later) monumental construction (1997: 106–115). Aside from fruitwoods (fig, mulberry, palm), at various periods he lists eleven archaeologically attested species, of which all but walnut, cedar, and oak were probably local. Of these, mulberry, palm, poplar, and willow are all noted in 'Ubaid contexts. Dozens of other trees and woody plants are attested in later economic and lexical texts. Many are associated with boat- and ship-building, others with fascine construction used in irrigation and flood control, and still others with manufacture of construction tools.

transport. Throughout the ‘Ubaid, archaeological evidence from the southern alluvium is consistent with a deltaic environment shading from freshwater and saline wetlands, through an estuarine mixing zone, to brackish Gulf waters.

EARLY–MIDDLE URUK

Site visibility increases markedly for settlements of the Early/Middle Uruk periods (4250–3800/3800–3450 BCE). This visibility—nearly 600 sites in the combined Nippur and Warka Survey Areas—has been interpreted as an opening up of new land area to irrigated grain cultivation. However, this settlement “expansion” *as compared to earlier periods* may well be an artifact of site visibility, and indicates only the vertical limits of aeolian scouring through soft basin silts to expose numerous smaller settlements invisible to us from the previous millennium.

As another step in gaining some sense of to what degree and depths surface exposure of settlements may be roughly comparable across the Warka basin, without correcting for rates of founding or abandonment, but merely averaging the number of sites visible in any given century, we note that in aggregate 200–400 settlements per millennium were apparent from the fourth to the late first millennium BCE (Figure 77). This may be compared to a mere double handful before that (and nearly double that number thereafter). This suggests that sites of the Early Uruk lie at the border of visibility between earlier and later periods. Our vision of all but the largest and most exposed ‘Ubaid sites is at best dim. As discussed above (page 149), Early Uruk sites are far more numerous. But, as discussed below, they still appear clustered around turtlebacks and avulsive fans, and along later levees near canal works where early

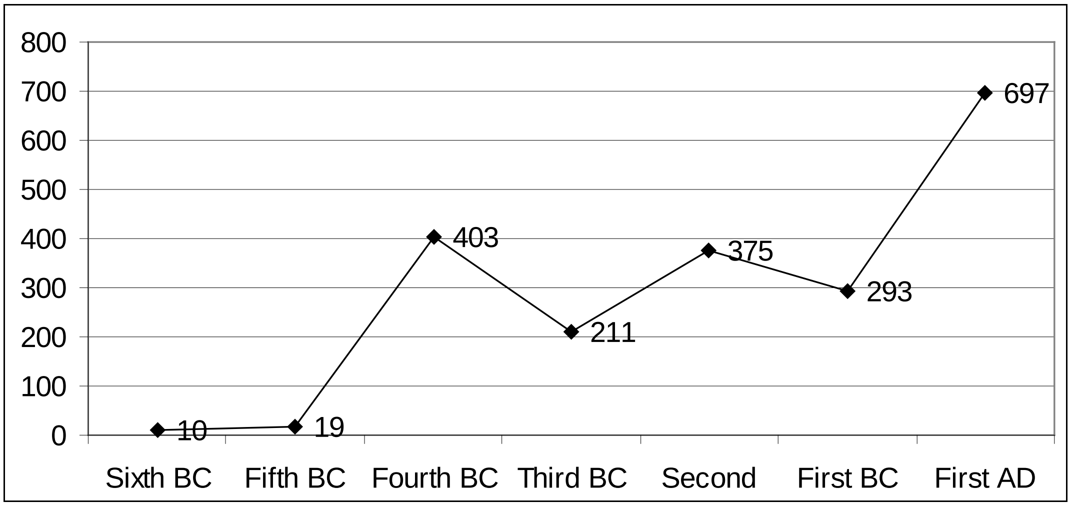

Figure 78: Number of sites *visible* per millennium, expressed as a weighted average of sites visible per century.[84] This is intended only to assess, in the absence of a uniform coring program across the basin, to what depths archaeological materials have been more-or-less uniformly exposed. It is a different measure than the number of sites occupied at any one time, the rates of site foundation or abandonment, or the duration of occupation of any particular site—measures that, to be validly comparable through time, must first assume proportional exposure of preserved materials from the periods compared. See also Figure 81.

materials would have been upcast by construction, and where bordering surface sediments are most deeply scoured by deflation. Indeed, where scouring is most severe, later occupations may be ablated, while elsewhere, as compared to those of later periods many others may remain unexposed. Only from the Middle Uruk onward may we presume comparable degrees of surface exposure among periods.

[84] Sites were counted by period; periods were assigned discrete durations, counts were averaged by century and aggregated by millennium. For example, assume that the Nth millennium (M), lasting 10 centuries, begins with period X, which lasted for 150 years. The duration of X in centuries (D_X) is 1.5. Period X was followed by period Y, which lasted 950 years (D_Y=9.5), of which 8.5 centuries occur during M (10–1.5=8.5). If 200 sites were assigned to X, and 98 sites were assigned to Y, the average number of sites visible per century for period X (V_X) was 200/1.5=133.3. The average number of sites visible per century for period Y (V_Y) was 98/9.5=10.3. The number of sites visible for the millennium (V_M)is the sum of the weighted centennial averages, that is: $V_M=(D_X *V_X)+(D_Y *V_Y)=$ (1.5*133.3)+(8.5*10.3)=(200+87.5)=287.5.

Trends do begin to become apparent, even though a smaller proportion of buried Early Uruk sites may have been exposed, and discriminating the Middle from Late Uruk periods in surface survey was at the time problematic (depending as it did on shifting pottery assemblages, not clearly diagnostic forms). By mathematically correcting for period duration and rates of founding and abandonment, Susan Pollock estimates that, throughout the heartland, about 170 Early and Middle Uruk sites would have been occupied at any one time (Pollock 1999: 71). Within the Warka basin, four new Early Uruk sites clustered on the fan south of Shurrupak (Figure 56); net weights and spools attest to a continuity of purpose with earlier fishing sites still occupied there.[85] Three sites are added to the Karkar fan; the semicircular chain of sites thus formed between Karkar and the modern Shatt al-Gharraf presages the later string from Bad Tibira to Larsa. Both suggest that these larger settlements demarcate a littoral boundary zone, as at Turaba–Abu Dakar (Figure 67). Four more sites[86] lie at the edge of a sediment lobe at the southeastern edge of the Shurrupak fan, funneling into a chain of six more sites exposed along channel junctions enroute to Larsa. Several cluster around Uruk itself (no doubt more are disguised beneath subsequent occupation there), and two peer through the heavy sediments in the modern agricultural zone between WS230 and Abla (Figure 75).

In the Eridu basin, while only a few other sites were classified as Early Uruk, based on a handful of sherds and the absence of Bevel-Rim Bowls characteristic of the

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[85] Weights: WS23; spools: WS20, WS24; earlier: WS42; also: WS22.

later fourth millennium (Wright 1981), Eridu itself grew to at least 40 hectares. The site cluster at Rejibah may also represent silt-covered fragments of another large town. Assessing whether or not this indicates a hiatus in settlement foundation in the southern marshes depends upon better dating for sickle manufactures, and an assessment of the persistence (or not) of later ‘Ubaid pottery traditions. The four that are added cling to the basin rim and its egress to the sea, suggesting that earlier sites within the basins remain buried by fluvial silt and aeolian sand. Spot elevations clearly show the Eridu basin, although in places even today no more than three or four meters above mean sea level, separated from present-day Gulf waters to the west and south by the rising Arabian plateau; and to the southeast by a 100-kilometer broad expanse of sandy uplands standing over 24 meters above current sea level—on which dune fields show no trace of intervening shorelines (Generalstab 1941, Soviet Union 1991a, 1991b). To the east and northeast, the depression is flanked by a sandstone ridge (the al-Hazim), which *rises* from three meters to 46 meters above mean sea level from northwest to southeast (Safar, Mustafa, and Lloyd 1981: 30). Imagery suggests that its northern face may have been trimmed by water, as is suggested by the marine sediments at core D. Yet, as discussed in the previous section, there is also much evidence of the Eridu depression having formed a closed, marshy basin, characterized by pooling and ponding of water, derived in part from wadis down-cutting from the Arabian plateau, but mostly from Euphrates flooding. The cut through the Hazim

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[86] WS107, WS109, WS118, WS201.

indicates outflow toward the Gulf, passing into the well-defined levee system skirting Ur and Tell al-Lahm. We might speculate that, as at H3, the cluster of early sites at this cut demarcate a tidal inlet where salt marsh grasses were harvested, shellfish were gathered, or fishing expeditions launched.

In associating archaeological sites with those aspects of deltaic terrain now visible, it is clear that ‘Ubaid towns and the later cities clustered on “turtlebacks” (Adab, Girsu, Lagash, Nina, ‘Oueili, Eridu[87], and site clusters WS230–32),[88] and sprawled over levee junctions and distributary clusters (Shurrupak, Uruk, Ur, Karkar, Umma, Larsa, and settlement cluster WS125–29.)[89] (Figure 78).

Investigations of the Nile delta (van den Brink 1988, 1993; Butzer 2001) and Chad (Holl 2001) show that in lacustrine borderlands characterized by seasonal marsh, turtlebacks have long histories, and initially comprised wet-season retreats for cattle herders who, as waters receded, moved animals down slope to graze resulting pastures. In Mesopotamia too, as rising sea level accelerated delta formation, these settings no doubt provided mid-Holocene “high ground” retreats, accessible by boat (especially during wet seasons when water inundated the landscape), but beyond the reach of seasonal inundation.

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[87] Eridu’s location is difficult to classify, as it seems to have been situated on paleodunes embraced by distributary arms within an active alluvial basin. The point is that, compared to its surroundings, it embraced the (comparatively) high ground.

[88] As well as WS298, WS260, WS169, WS218, ES 5–7 (Rejibah), EP137.

[89] As well as ES 156.

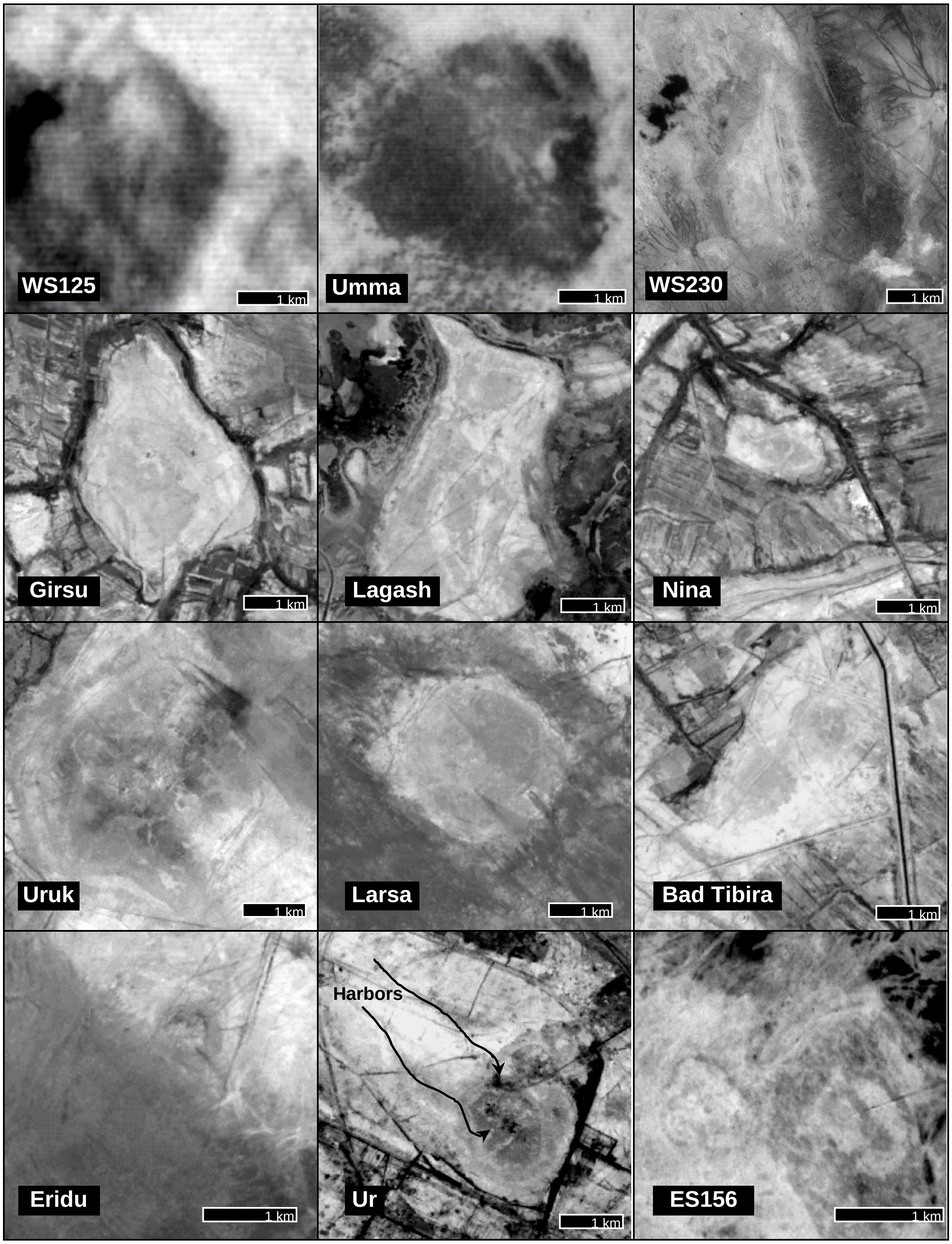

Figure 79: Deltaic Mesopotamian cities and surrounding wetlands, past and present. WS 125, Umma, WS230, ES156: USGS CORONA May 1968. All others: NIMA SPOT 1991. Scales approximate.

From the Early Uruk onward, when smaller sites become more visible, the distribution of smaller settlements near these larger towns suggests that the second ("cluster") type may have been associated with control of avulsive nodes at the head of flood basins, not only with unitary channels per se. Several cases in point include the enduring fans and associated wetlands south of Shurrupak and Karkar (Figure 75), enduring if shifting occupation at and near junctions near Nagsu and leading to Larsa,

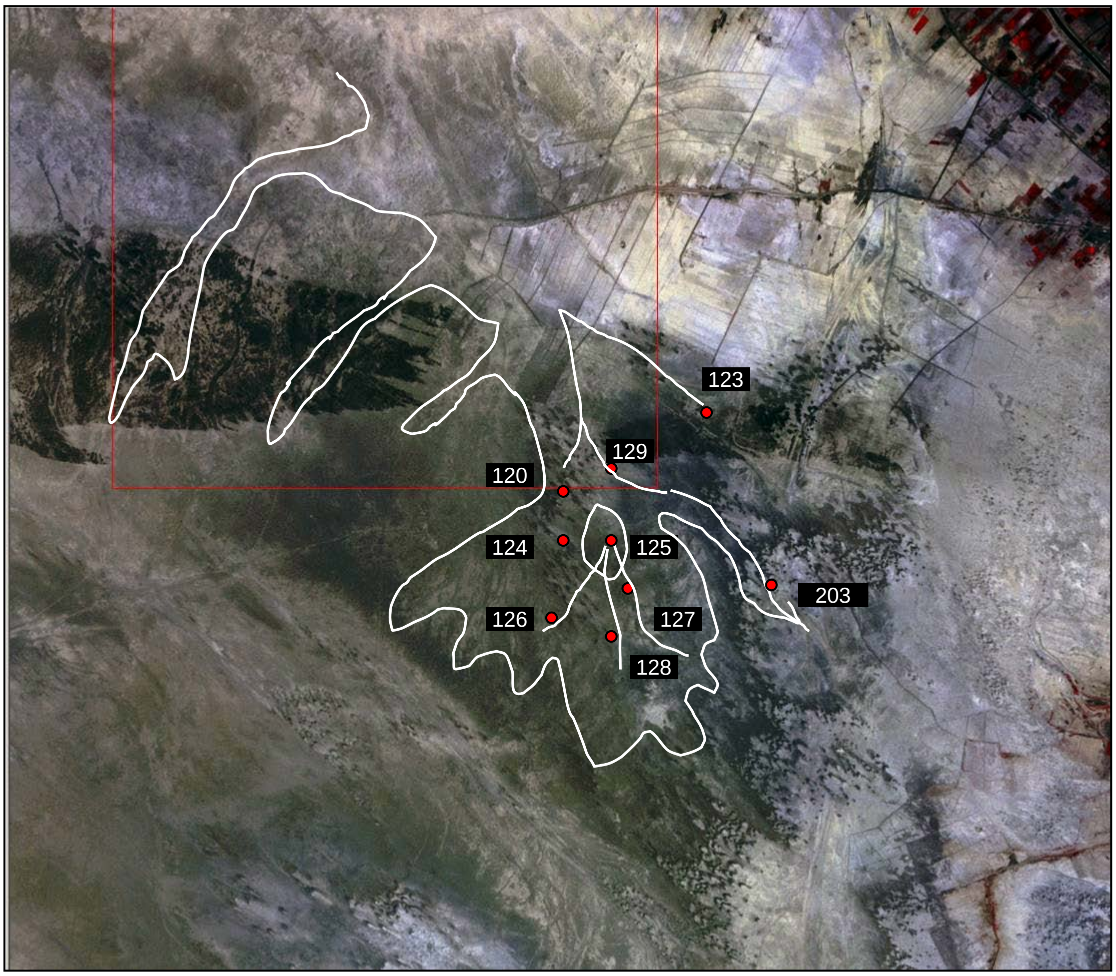

Figure 80: Site 125 and environs, including possibly associated sediment fan (outlined in white). Archaic strata are obscured by overlying sediments (Figure 60), but insofar as any channel pattern may be discerned, it may be explained by opportunistic basin cultivation, as above. ASTER 2001, Bands 1, 2, 3N with Gaussian enhancement.

and the later canals that appear to have previously rimmed wetland basins (discussed on pages 172, 193). A particular case made partly visible by deflation is the cluster of small settlements fanning southwards from WS125 which seems placed to control a series of modest irrigation off-takes (Figure 79; see Adams1972: 28 and fig. 14). While associated strata are obscured by overlying sediments (Figure 60), insofar as any channel pattern may be discerned, it invites a comparison to settlement on the deltaic fans of Suwaich marsh, south of Amara (Figure 80). There, accelerated by rice cultivation, light fingers of sediment, tipped with farming communities that stretch in bands across the lobe, extend into the dark waters and grey reed brakes inhabited by mat weavers, who also provide a harvest labor force. Only the more prominent communities, representing a small fraction of the area's population, attain sizes of even a few hectares. Dendritic fans are kept clear by fishing and harvesting traffic to and from the marsh. Over time, they build sediment banks which control dry-season flow though the channels. Larger marsh communities become concentrated along waterways through the reed brakes.

This lower Tigris comparative refutes arguments against the possibility of early reliance on Tigris water, made on that grounds that the sheer volume of annual flood surges exceeds any early technological coping capacity. As discussed in Chapter Three (page 101), flow at any given tail of such a developing distributary system is much attenuated, and even assuming only two or three main branches at any given time, even at the major nodes flow rates are unlikely to have exceeded 2,000 cumecs. More important was the ability to cope with annual cycles of rising and falling wetland water tables.

If founded at locations suited to both basin cultivation and nearby wetland exploitation, even aside from climatic fluctuations, the inexorable process of deltaic progradation would have necessitated continuing control of avulsive fans and channel junctions in order to maintain (or replicate) these conditions: “localized cleaning and

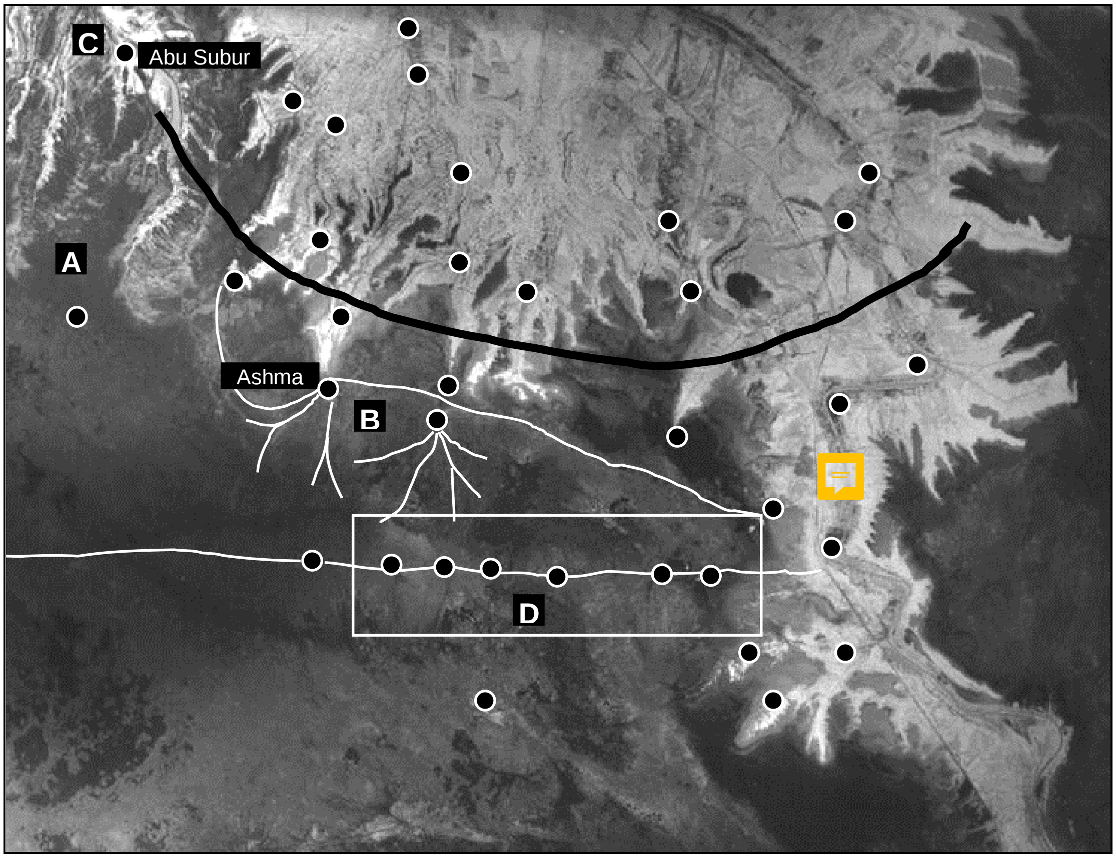

Figure 81: Deltaic progradation into Suwaich marsh. A. Accelerated by rice cultivation, light fingers of sediment, tipped with farming communities that stretch in bands across the prograding lobe (black line), extend into the dark waters and grey reed brakes inhabited by mat weavers, who also provide a harvest labor force. Only the more prominent communities (black dots), representing a small fraction of the area’s population, are shown. B. Dendritic fans of waterways (white lines), as at Ashma, are kept clear by fishing and harvesting traffic to and from the marsh. C. Over time, they build sediment banks, as at Abu Subur, which controls dry-season flow though the channels. D. Larger marsh communities are concentrated along waterways through the reed brakes. Boxed: see Figure 66.

management of [a] node of avulsion or bifurcation could have maintained flow in both channels...thereby substantially increasing the water supply and transportation network...” (Wilkinson 2001: 255). Fourth millennium marine incursion, even as it drowned former marshes, would have accelerated sediment deposition in the upper reaches of the Warka survey area, accounting for the prograding band of settlements there (Figure 57, Figure 75).

Subsequent falling levels, as already noted (Chapter Three), resulted in the building of an estuarine salt marsh. Along the building Uruk–Ur levee system, tidal flushing would have influenced cultivation regimes as far inland as Uruk itself, encouraging date palm and levee garden crop production. This would have been accompanied by at least seasonal marsh formation over all but the highest ground of the Warka and Eridu survey areas, as the outlets of the combined Tigris and Euphrates discharge became flooded, slowing drainage to the sea. However, intensification of cattle-keeping in riparian and littoral habitats also would have steadily degraded browse and the watershed, necessitating intensified fodder gathering and production (Belsky 1999).[90]

Late Uruk–Jemdet Nasr

During the latter part of the fourth millennium, this trend toward (probably agricultural) colonization of prograding sediments at the fresh-brackish boundary

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[90] The riparian regime appears to have been relatively stable until at least the late third millennium BCE (Akkadian), when the Euphrates bed appears to have flipped into the channel skirting the Eridu depression (Figure 25). This channel, as well as the immense overburden of the Ur—Tell al-Lahm levee, could well obscure older sites.

becomes more clear. Refer back to Figure 57, and note the belts of yellow (Late Uruk) and orange (Jemdet Nasr) sites spanning *across* the Warka basin. Compare these to the distribution of marshland settlements depicted at Figure 80. When more fully contextualized by what we now know of the surrounding terrain at that time—a prograding delta saturated with the waters of the combined outflow of the Tigris and Euphrates (Figure 75)—these yellow and orange bands of Late Uruk and Jemdet Nasr settlement appear, not as pearls strung along north–south trending strings, but as entire bead necklaces draped west–east across the sediment fans pushing outward into gulf waters. Indeed, this trend may even be visible from the ‘Ubaid 4, when marine transgression approached its maximum, slowing river flows, triggering sedimentation, and promoting marsh formation in the basin. The dark blue squares arrayed across the turtlebacks on Figure 57 and Figure 75 may well demarcate that boundary “half-water and half-land, on the fans of southern Babylonia” of this chapter’s opening epigraph.

Among surface evidence for the Late Uruk (Table 12), added to net weights, spools, and spindle whorls, were a profusion of mace heads, indicators of local office. [91] Within the Eridu survey area, although only two new sites are recorded,[92] both are situated on the developing Ur–Lahm levee system, which by this time cores C and D show to have been passing through an estuary zone or brackish marsh (Aqrawi 2001) (Figure 40). Late Uruk (Uruk IVA) seals, sealings, and tablets excavated at

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[91] Weights :WS110, WS219. Spools:WS28, WS48, WS191, WS219, WS282, WS297. Whorls: WS137, WS181, WS185, WS219, WS260, WS274, WS407. Maces: WS109, WS129, WS152, WS162, WS219, WS230, WS242, WS260, WS262, WS274, WS276.

[92] ES63, ES171.

Warka

Table 12: Fourth Millennium BCE Surface Debris (diagnostic and non-diagnostic)

Debris	Manufacture	Presumed Purpose
kiln wasters	pot sherds	storage, cooking, consumption, display
	wall cones	decoration
	clay sickles	grain harvest, reed cutting
	clay mullers	grinding
	bevel-rim bowls	votives, rations, bread molds, curd separators
	loom weights	cloth
	spindle whorls	cloth
	tokens	accounting
	stamp seals	accounting, demarcating
	figurine fragments	votives, toys
chipped stone	tools	cutting, chopping, piercing
	cylinder seals	accounting, demarcating
ground stone	tools	pounding, grinding, hammering
	vessel fragments	various, grinding, display
	beads	display
	mace heads	hunting, fighting, display
	net weights	fowling, fishing
marine shell	beads	display
	fish hooks	angling
metal prills	mace heads, weapons	hunting, fighting, display
mold fragments	talismans	votives
bitumen fragments	Boats, baskets	waterproofing, cementing, sealing

depict palms, frogs, livestock emerging from reed byres, and hunting scenes with pigs stalked among reeds. Many tablets show the clear imprint of the reed mats upon which they lay as they dried (Boehmer 1999: 51–56, 66–67, 71–74, 90–104). Contemporary protoliterate lexical lists include dozens of ideographs for reeds and reed products, waterfowl, fish, dried fish, fish traps, dried and processed fish flour, as well as those for cattle and dairy products, and 58 terms relating to wild and domestic pigs. The slightly later ‘professions’ lists record offices including ‘fisheries governor’ and ‘fisheries accountant’ that endure one and one-half millennia (Englund 1998).[93]

The continuation of this progradation cycle is evident beyond the fourth millennium BCE. When the millennium-long duration of the Uruk period is considered against the two short centuries of the Jemdet Nasr, the centennial average for Uruk settlement occupation pales by comparison to the latter (Figure 81). This volatility may have accompanied deltaic progression. As the border between cultivable land and harvestable wetland moved southeastward, a new band of settlements pushed forward in the direction of Abla (Figure 75). Within the previously inhabited zone of

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[93] See the Cuneiform Digital Library, <http://cdli.mpiwg-berlin.mpg.de>.

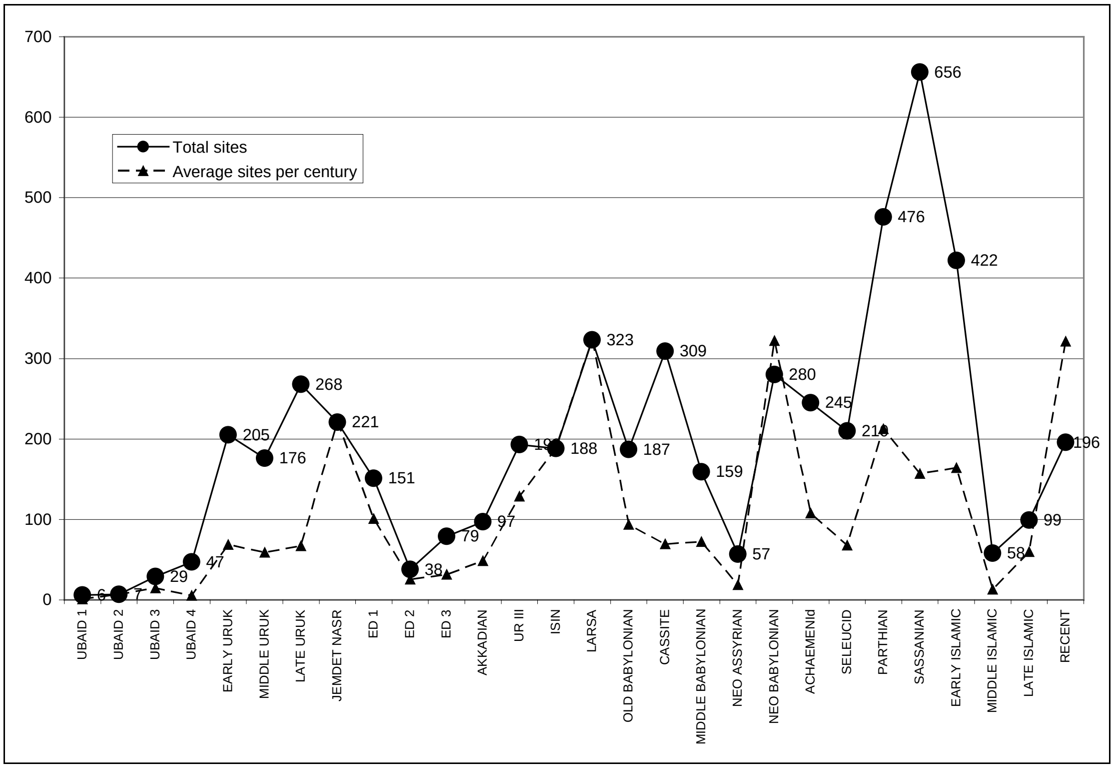

Figure 82: Number of sites (x) by period (y), Warka, Eridu, Nippur, and East Gharraf survey areas, versus average number of sites per century. Calculation method: note 84.

the Warka basin, notable is a match between the geographic clustering of earlier sites around centers on turtlebacks, with Adams' hypothetical Jemdet Nasr/Early Dynastic I territories, based on site sizes and nearest neighbor analysis (Adams 1981: 20, fig. 8). The high prevalence of mace heads at these clusters suggests that turtlebacks were becoming marked with badges of local office. Occupation expanded at WS230–233 (Figure 74), situated on a turtleback and displaying an internal structure of modest,shallow waterways that resemble modern waterways cleared during wet seasons and enlarged during dry, in order to extend boat transport through sites and to their surrounding marshes. (Salim 1962; Thesiger 1953, 1964). The similarity of sprawling Late Uruk–Jemdet Nasr settlements 281–282 to those in modern marshland communities was noted by Adams and Nissen in 1972 (pp. 6, 25, fig. 12).

Early Dynastic

Within the heartland, throughout the Early Dynastic era, on a centennial basis average aggregate site area increases markedly, even as the number of settlements falls (Figure 82). This urbanizing trend toward fewer, but bigger, settlements within the Warka basin is explainable not only as a phenomenon of population being drawn in from immediately surrounding, drying wetlands, but as the visible part of the ongoing progradation cycle. Beyond the southeastern limits of the Warka survey area, early sites become nearly invisible, buried beneath the unsurveyed sediments along the Shatt al Gharraf. What few are recorded, suggest that this progradation settlement process, with concomitant consolidation of urban centers behind the advancing band of smaller settlements, continues forward. The advancing sediment lobe was bounded

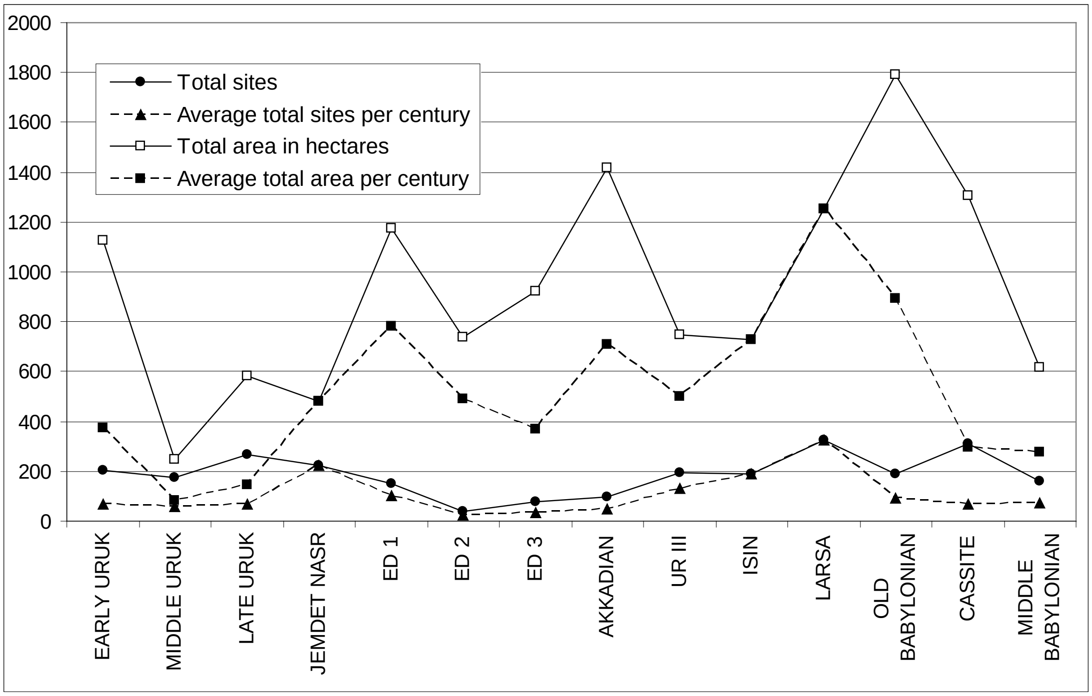

Figure 83: Aggregate site area by period, versus average area per century. Note that the aggregate area recorded for all known sites of the "urbanizing" Early Dynastic is equivalent to the area of two small towns along the Shatt al Gharraf.

by what would in Old Babylonian times become a canal, following a sweeping arc from Bad Tibira to Larsa (Steinkeller 2001). At this earlier time, however, it would have facilitated boat traffic passing from settlement to settlement across the edge of the marshy zone (as at Figure 80). At the same time, as the climate dried, the sea level dropped, and the delta protruded further into the estuary zone (Figure 75), the waterways extending southeastward would have maintained connections back to the urban core. As smaller settlements shifted southeastward, out of the surveyed area, following the littoral zone, the integrated centers remained behind and grew, supplied by a forward-expanding hinterland. This model, of mid-late fourth though mid-third millennium BCE settlements prograding along behind the advancing delta is consistent with Pollock's calculations (using Dewar corrections), which show high rates of settlement founding and abandonment in the Uruk region for the Late Uruk, Jemdet Nasr, and Early Dynastic I periods, (Pollock 1999: 73, Table 3.2).

This would suggest that, while palm groves, gardens, temples, kilns, and other institutions were consolidated on turtlebacks and levees away from seasonal inundation (by peoples well-accustomed to thorough exploitation of wetlands), concomitant with intensified agricultural production, reed and other marsh products were becoming intensively harvested to underwrite urbanizing consumption. As discussed above, multiple canal off-takes cutting through the relict levee abutting site ES156 clearly directed water flow into the alluvial basin adjacent to the site—but *not* into any apparent field irrigation system. Instead, the water flow seems designed to augment catchment into what is now a desiccated wetland. The surface morphology of the area is directly comparable to desiccated habitation areas on the seasonally inundated edges of massive, permanent marsh reed beds such as those of the al-Khuraib marsh south of Amara (Figure 70).

East of the Warka survey area, an ancient levee, cut by modern canals, extends into a flooded marsh. To its south, partially swamped, Tell al-Hiba—ancient Lagash—becomes a seasonal island surmounted by multiple occupation mounds (Figure 83; Figure 21, Figure 22). Scattered with kiln debris are small rises on the western margins of “a large, roughly semicircular area that has the appearance of a dry lake bed…flooded at various times in the past by the marsh, and as a result covered with a thick layer of dried mud that buried most of the artifacts” (Carter 1990: 61). A deep sounding through this rise (Figure 83, black dot), much disturbed by later cuts and

Figure 84: Tell al-Hiba (Lagash) surmounts a turtleback, appearing as an island in the (black) flood waters. Dot: deep sounding. Black line: westward limit of flood zone. White line: outline of drowned surface. See also Figure 21, Figure 22. CORONA May 1968.

pits, found seven meters of Early Dynastic I trash above the (obviously high) water table (Hansen 1978: 76). Later surface survey turned up a few upcast Uruk sherds, indicating the possibility of earlier occupation (Carter 1990: 61), but the lack of significant quantities of surface material older than late fourth millennium is consistent with a mid-Holocene marine transgression that either precluded permanent habitation altogether, or confined it to relatively small areas, not subject to seasonal inundation, now deeply buried beneath subsequent debris. Even

> the extent of the Early Dynastic city is difficult to estimate. No city wall has been discovered, and a significant portion of the ancient ruins lie below the reed-covered marshlands that surround the site on three sides. The central area of the site extended west…but it is now covered by the marsh. One mound, now cut off from the rest of the site by water, was found to be covered with sherds of Early Dynastic date. Through most of its history, and particularly in the Early Dynastic period, Lagash, al-Hiba, had a flourishing ceramic industry. This was perhaps due to the proximity of fuel from the marshes. (Carter 1990: 62).

Among deltaic cities, Lagash—although probably well above the mean—was hardly unique in its littoral reliance, which continued through the third millennium BCE. Cylinder sealings from the ED I Seal Impression Strata at Ur depict reed structures (Amiet 1980 [1961]: 333–344), cattle fed in and lead from reed byres (Amiet 1980 [1961]: 337, 342, 344); personages poled along fish-filled watercourses in high-prowed boats (Amiet 1980 [1961]: 300), fishing from small watercraft (Amiet 1980 [1961]: 310), and persons carrying tribute of fish and waterfowl (Amiet 1980 [1961]: 302, 303).

During the historical Early Dynastic III period (2600–2350 BCE), at the height of Lagash's power, sea levels once again rose to one meter above present (Figure 30) (Sanlaville 1989; Potts 1997: 33), and thus in areas not yet transformed by state irrigation and drainage schemes, a similar hydrologic regime to that of the late

Chalcolithic probably prevailed. Texts found in Girsu of the é-mi household, headed by the wife of the ruler of the state of Lagash, detail produce from a number of dependent laborers, including fishermen. Renamed the é-Bau under Urukagina of Lagash, of the approximately 1,200 members of the productive household, 100 were listed as fishermen, and another 125 as oarsmen, pilots, longshoremen, and sailors (Maekawa 1973–4; van de Mieroop 1987). Economic activities included fresh- and salt-water fishing, and fish and dried fish brought into the household were both deposited in the store-room and issued as purchase goods to merchants acting on behalf of the household (Postgate 1994: 114, 202).

Umma texts record quotas for production of reed, bitumen, boats, mats, and standardized fish baskets (de Genouillac 1920: 603–6). Robert Englund has treated at length the regulation and management of late third millennium Ur III fisheries (Englund 1990). At al-Hiba, ED III faunal remains included not only several species of mollusk shell used in jewelry manufacture, but two of marine fish, as well as edible conches and bivalves, and six types of waterfowl including duck, flamingo, gull, coot, cormorant, and spoonbill—the latter three particularly preferring open marshes, shallow lagoons, and estuarine mud flats (Carter 1990; Kenoyer 1990: 67; Mudar 1982: 29–30, 33–34) (Table 13, Table 14, Table 15). Later third–second millennium BCE (land) itineraries from Sumer to Susa run first northwest to the Diyala region, then southeast to their destination, suggesting a requirement to circumvent a marine incursion (Leemans 1960, Howell 1964).

Analysis of faunal remains from the 1970–71 excavations of distinct temple and administrative/residential precincts at Lagash showed a decided separation in their distribution—and that, just as excavation over-focused on massive temple architecture has skewed perceptions regarding the distribution of Mesopotamian settlements, osteological analysis over-focused on mammalian megafauna has skewed attention away from the littoral component of domestic diet. For the vast majority of the working population, the primary dietary protein source was dried fish, and these figure in administrative texts from the earliest protoliterate lexical lists onward (Adams 1969: 48, Adams 1981: 142, Englund 1998: 94). But, at Lagash, all fish, fowl, and shell were found in the administrative/residential zone; none in that of the temple. This marked differentiation in consumption was reinforced by mammalian finds. In the temple precinct, sheep/goat comprised a proportionally higher; cattle a slightly higher, and pig a significantly lower percentage than finds in the residential/administrative precinct (Mudar 1982: 31). It is tempting to conclude that by the late Early Dynastic, (elite) mutton and beef had become appropriate; pork less so; and fish inappropriate as temple offerings and priestly food. This would appear to be a marked reversal from the ‘Ubaid precincts at Eridu—a reversal marking the transition from a time of social integration served by fish as everyman’s food, to one of social hierarchy marked by fish as poor man’s food.

D. Toward Marshland Hinterlands?

I began this chapter by laying out a number of assumptions that have long underlain theories of urbanization in the alluvium of southern Iraq. Methodologically, against arguments that might hold that these early periods are beyond the reach of surface images, I have shown both where conditions for photographic examination of archaic surfaces and their associated archaeological sites are less than ideal, and where such archaic surfaces may indeed have been preserved. This study indicates that, during the fourth–third millennium BCE, the locale encompassed by the Warka Survey Area was most likely the locale where the waters of the Tigris and Euphrates met the sea. However, while those fourth millennium waters probably did flow through the Warka basin, small patches notwithstanding, no discrete channel bed of any length earlier than the Jemdet Nasr period—if that—is itself now visible at the surface. We must also bear in mind that, for these early periods, not all water*ways* across marshlands need be interpreted as water*courses* with discrete banks.

Associating archaeological sites with these and other aspects of deltaic terrain visible on imagery shows that, during the ‘Ubaid, towns and cities clustered on turtlebacks generally beyond the reach of seasonal flooding. By the Early Uruk, we can see more sprawling sites clustered around distributary junctions propitious for opportunistic basin irrigation. By the Late Uruk, we can see that smaller settlements pushed southeastward into the delta, following prograding sediment fans, and that this process continued into the third millennium BCE.

Throughout this analysis, I have attempted to counter those historical assumptions laid out in the opening pages, arguing that at the time and space when and where urbanizing trends first become detectable in Mesopotamia, throughout the fourth millennium BCE and on into the third millennium (1) the lower alluvium was not perfectly flat, but was characterized by uneven waves of sedimentation and deflation; (2) furthermore, it was not transited by two great rivers, so much as inundated by multiple distributary fans that formed wetlands such as those of the modern inner (freshwater) and outer (brackish–saltwater) deltas; and (3) rather than being devoid of resources, it afforded many unique opportunities beyond those related to irrigated grain cropping. Rather than supporting a model of social transformation driven by dependence on irrigated grain crops, this re-visualized heartland of cites suggests a settlement progression beginning with ‘Ubaid opportunistic dependence on littoral biomass which, by the Early Dynastic, had proceeded to intensive cultivation of wetland forelands as “agriculturalized” marsh zones.

In the next chapter, by focusing on that resource most characteristic of the Iraqi marshes—the reeds that constituted “one of the few locally available building materials outside the soil itself” (Adams 1969: 48)—I will elaborate this hypothesis and its implications more fully.

Table 13: Hydrophytic Plants Excavated from Archaic Contexts in Southern Iraq

Hydrology zone	***Genus***	**species**	**Common name**	
			U.S./U.K.	**Arabic/Sumerian**
Brackish/salt	*Spartina*		Salt/cord grass	
Brackish	*Scirpus*	maritimus	Bul-/Sea club-rush	Berdi/ ukur, aški
Flood/drought	*Salix*		Willow/osier, withy	
Flood/drought	*Phoenix*	dactylifera	Date palm	
Flood/drought	*Populus*	euphratica	Poplar	
Flood/drought	*Arundo*	donax	Giant reed	
Shallow fresh	*Carex*		Sedge	
Shallow fresh*	*Typha*	angustifolia	Cattail/ reedmace	
Shallow–Medium*	*Phragmites*	australis	Reed/ reed grass	Qashab/ gi
Shallow–Deep	*Cyperus*	rotundus	Papyrus	
Medium fresh	*Juncus*	acutus, arabicus	Rush	Esel/ ninni$_2$

* Some now also occur in brackish conditions.

Table 14: Fishes Excavated in Southern Iraq. *Indicates ‘Ubaid–Early Dynastic III Contexts

Zone	**Family**	***Genus***	**species**	**Name** U.S. (Arabic)	**A. Salabikh**	**Nippur**	**Uruk**	**Lagash**	**Isin**	**Oueili**	**Eridu**
Marine coastal	*Pomadasidae			Grunters							?
Marine coastal	*Sparidae	**Acanthopagrus*			X		X	X	X		?
Marine coastal	*Chondrichthyens									X	?
Marine coastal	*Pleuronectes									X	?
Fresh	*Siluridae	**Mystus*	haleppensis?	Catfish (girri)	X	X		X			
		Silurus	triostegus		X	X	X		X	X	
Fresh	*Cyprinidae	**Barbus*	*luteus	Carp (bynni)	X			X	X	X	
			sharpeyi		X	X	X		X		
			esocinus	(bizz)	X	X	X				
			xanthopterus		X	?	X		X		
			grypus		X	?			X		
			kersin		?	X	X		X		
		Asipius	vorax	Barb (shiliq)	X		X		X		
		Acanthobrama			X						
		Ciprinion			X						
		Alburnus			X						
		Thachysurus	thalassinus			X					
		Plotosus	anguillaris				X				
		Mastacembelus	mastacem		X						
Fresh	*Bagridae									X	
Catadromous	*Mugilidae			Mullet, shad	X	X	X		X	X	
		Hilsa	ilisha		X						
		Plectorhynchus			X						
		Johnius	maculates				X				
		Sphyraena	jello		X						
		Pristis			X						

Sources: After Sahrhage 1999; Boessneck 1992, Boessneck and von den Dreisch 1989, 1992; von den Dreisch 1986, Desse 1983, Mudar 1982, Gautier 1978.

Table 15: Native Mollusks and Crustaceans of Southern Iraq and the Gulf, Identified by Species from 'Ubaid–Early Dynastic III Contexts

Zone	Type	*Genus*	species	Common name	Use	DATES	LOCATIONS/SOURCES
Estuarine	Crustacean	*Balanus*	trigonus	Barnacle		Ubaid 1	H3 (Kuwait) (Carter, pers. com. 2003)
Fresh stream	Bivalve	*Unio*	tigridis	Mussel		Ubaid 1–2; ED; 1–2m CE	H3 (Carter, pers. com. 2003), Usailia (Wright pers. com. 2003); Abu Salabikh (Postgate 1980:74), Nippur (Moorey, 130); Larsa-Oueili (Sanlaville 2003: 144)
Marine Reef	Bivalve	*Pinctada*	margaritifera	Pearl oyster	Mother-of-pearl	Uruk IV-III; ED	Uruk; Ubaid, Ur, Girsu, Adab, Kish but most common at Asmar and Mari (Moorey 1994: 139)
Marine	Gastropod	*Conus*		Cone snail	Beads, rings	ED	Al-Hiba (Carter 1990:95)
Gulf Coast (Oman)	Gastropod	*Lambis*	truncata sebae	Spider Conch	Vessels, inlay, amulets	ED	Kish, Adab, Shurrupak, Tello, Ur, Ubaid (Moorey 1994: 133, 136)
Estuarine	Bivalve	*Arca*	ehrenbergi	Cockle	Food, pigment cups	EDI–III	Kish (Algaze 1983–4: 175); Ur (Woolley 1955: 104, 1934: 245); Lagash (Mudar 1982: 34)
Marine Reef	Bivalve	*Spondylus*	gaederopas	Oyster	Food	EDI–III	Kish (Algaze 1983: 175); Al-Hiba (Kenoyer 1990: 67)
Estuarine	Bivalve	*Anadara*		Cockle	Pigment cups	EDII–III	Al-Hiba (Kenoyer 1990: 67)
Estuarine	Bivalve	*Cardium*		Cockle	Pigment cups	EDII–III	Ur (Woolley 1955: 104, 1934: 245); Al-Hiba (Kenoyer 1990: 67); Abu Salabikh (Martin 1985:4)
Marine littoral	Gastropod	*Strombus*	decorus persicus	Persian conch	Food, rings, spindle whorls	EDII–III	Ur (Woolley 1955:71); Al-Hiba (Kenoyer 1990: 67); Lagash (Mudar 1982: 34); see Moorey 136.
Marine shallow	Gastropod	*Thais*	mutabilis	Murex	Dye	EDII–III	Al-Hiba (Kenoyer 1990: 67)
Marine	Gastropod	*Cerithium*	caeruleum	Whelk		EDII–III	Al-Hiba (Kenoyer 1990: 67)
Gulf (Oman)	Gastropod	*Engina*	mendicaria	Turban snail	Pendants, beads	EDII–III	Abu Salabikh, Telloh, Nippur, others (Moorey 1994: 130); Al-Hiba (Kenoyer 1990: 67)
Estuarine	Bivalve	*Dosinia*	erythraea	Clam	Food	EDIII	Lagash (Mudar 1982: 33)
	Bivalve	*Petunculus*	pectiformis	Scallop	Food	EDIII	Lagash (Mudar 1982: 33)
Estuarine	Gastropod	*Nerita*	albicilla	Turban snail		EDIII	Tosi et al 1981: 82; Lagash (Mudar 1982: 34)
Estuarine	Gastropod	*Olividae*	e.g. bulbosa	Cowrie	Necklaces	EDIII	Tosi et al 1981: 81, 91; Lagash (Mudar 1982: 34)
Marine shallow	Gastropod	*Thais*	carnifera	Murex	Dye	EDIII	Lagash (Mudar 1982: 34)
Marine shallow	Bivalve	*Trachycardium*	rugosum	Cockle	Food, cups, pigment cups	EDIII	Lagash (Mudar 1982: 33)
Marine	Gastropod	*Xancus*	pyrum	Sacred Chank	Food, rings	EDIII	Kish (Moorey 134); Lagash (Mudar 1982: 34)
Gulf (Oman)	Gastropod	*Fasciolaria*	trapezium	Whelk	Beads, inlay, cylinder seals	EDIII	Jemdet Nasr, Kish, Tello, Uruk, Ur (Moorey 1994: 132, 136)

V. CONCLUSION: MARSHLAND VISIONS

> We all do read the landscape, but we are not all equal in the process of "authoring" it.
>
> ———(Mitchell 2000: 139)

In this dissertation I have thus far sought to address two issues fundamentally engaged by any landscape reconstruction: Visibility and Visualization. By visibility I mean our ability to see and recover terrain and landscape evidence; by visualization our ability to make sense of what is recovered. I have thus far been especially concerned with the former (visibility), and I have dealt with this on a number of levels.

At the level of physical terrain, I have invested rather heavily in a detailed discussion of the taphonomy of archaeological sites in the lower alluvium, and their relationship to underlying geology. I felt this important, because in the course of this study—that is, while attending many panels and workshops, and in discussions with recognized experts in the field—it has become clear that disciplinary specializations and separations have tended to isolate crucial evidence in specialized journals, often behind eye-glazing walls of jargon.

Such divisions are not uncommon; nor is noticing them particularly insightful. But the effects of this division of labor have not always been obvious. It is not merely a matter that they have isolated strands of evidence (although this is always a problem). Rather, my concern has become that these divisions tend to create perceptual differences among their practitioners, based upon customary levels of analysis and geographic scale. No common language exists between those accustomed to examining point data from point sites, and those who examine broader phenomena from great heights. Thus, this entire work stands as a kind of plädoyer for the essential role of air and satellite photographs, at multiple scales, as both data sets in and of themselves, and as organizing frameworks for the integration of point data derived from borings and excavations with surface surveys, historical documents, and other ephemera—that is, for landscape visualization.

Having established—I hope beyond reasonable question—this re-envisioning of the physical terrain surrounding the early cities of southern Mesopotamia, I recognize that we must now begin in some systematic fashion to think through the social implications of those misunderstood wetland origins. There are some obvious ecological and economic approaches suggested by the technical findings presented in Chapters Three and Four. Further investigating these would require several seasons of intensive data collection: they must await a future work. Instead, I wish in conclusion to turn briefly to a third "V" that lies behind data visibility and underlies terrain visualization: Cultural beliefs about what can and should be done within a terrain, and social practices that govern what is done there. That is, I wish to turn explicitly to the problem of landscape vision. By vision, I mean an inherent sense of what should be; can be; might be: an idealized version of landscape that mentally transforms a sense of what is there, and imbues it with future possibilities of what could or should be there. Vision is, in that sense, the psychodynamic process that transforms a present physical terrain into an idealized—or an imagined future—landscape.

I have attempted to show how Western, European, Enlightenment cultural beliefs, coupled with Modern social practices, have limited in very specific ways questions posed, evidence seen, and data selected, even as the landscape vision informed by those beliefs and articulated by those practices utterly transformed the hydrology and terrain of southern Iraq. Clearly, over the past century, even apart from economic motivations and technical capacities, landscape vision—that is, ideas about what is, and what should be, the ethical, moral, and political ordering of space within the terrain of southern Iraq—has played an overwhelming role in determining the relationship of a people with their local terrain, and has utterly transformed their experience of it.

At this point, my preoccupation with some of the limits of that particular landscape vision—one informed by biblical and other traditions of scholarship, envisioning irrigated cities on a plain, believing in an Enlightenment social contract that placed a particular burden on "good" government to create "useful" farms from "wasteful" marshlands, and practicing Modern top-down, technologically engineered management schema that invested governmental authorities with rights of eminent domain in order to administer vast projects "for the common good"—rightly leaves me open to the criticism that "it is as though the English, French, and Germans have a society and culture, while the people of Iraq have nothing but a landscape" (M. Meeker 2003: personal communication). Of course, seriously addressing the question of whether archaeologists of early urban civilizations should consider social practices and cultural beliefs as variables—and how one might go about doing this—would require a book unto itself. However, in this concluding chapter, I will attempt a small move in that direction, by way of opening up further possibilities for future research.

To make this small beginning, in what follows I have chosen just one feature of the Iraqi wetland terrain—the ubiquitous reed—that, even in the face of overwhelming evidence of its cultural and social importance through time has remained largely invisible to those who could not or did not recognize the real significance of wetlands or the (economic, social, or cultural) value of "non-agricultural" products or communities. I attempt to show how, due to a peculiar cultural bias, the significance of reeds was systematically written out of landscape valuations by British colonial administrators. I contrast this view with that of Early Bronze Age depictions of reeds, in an effort to assess, in its broadest outlines, how the landscape vision of early Sumerian administrators differed from those of their millennia-later British counterparts.

Along the way, I also attempt to show that reeds were themselves at all times a valuable resource; an ecological component of the agro-pastoral system that have contributed significantly to rural surplus generation in the service of urban populations. Thus, their presence in or absence from administrative documents cannot be attributed to some simple calculation of their economic benefits or contribution. Rather, their presence or absence in administrative records becomes an explicit marker of the presence or absence of a felt sense of a social contract—of a sense of mutual recognition of and obligation between—urban and marshland inhabitants.

Almost from the moment of their landing at the mouth of the Shatt al-Arab, officers of the British Imperium counted, measured, assessed, and “improved” any place or product that might channel profit to their civilizing enterprise. Yet, while scarcely a person or thing moved through the Mesopotamian realm that was not packed in, loaded on, shaded by, warehoused under, fired with, or made of palms, reeds, or rushes; though not one donkey, horse, mule, sheep, goat, camel, cow, or buffalo grazed from birth to rendering pit without seasonal sustenance from wetland grasses; though hardly a floor was laid, wall was finished, roof was set, nor awning attached without woven matting or thatch filler, following World War I nearly four decades passed before any government attempted to measure or tax reed products, or to count reed fuel and fodder as an agricultural resource. The earliest accountants of Sumer—situated in towns intimately associated with neighboring marshes—suffered no such blinkered view. From the moment of regularized record-keeping, reeds and reed products figured as prominently in lexical lists and delivery tallies as grain, livestock, dairy products, and other storehouse commodities.

In 1863, after reflecting in glowing terms on the rich Gulf trade in pearls, dried fish, wool, cloth, dates, grain, and horses,[94] the British Political Resident at Bushire (on the Persian Gulf coast) reported to the Chief Secretary to the Government of Bombay that “the Arabian…portions of the Gulf coast-line may be capable of supplying at a profit hides, horns, glue, saltpeter, and wool” (Pelley 1863: 618). He was especially enamored of the enlightened government of the free port of Kuwait, and stressed its astounding potential as a locale for a coaling station, telegraph office, and steamer terminus (Pelley 1863: 620). By contrast, nearby Fao, he wrote, “would ill-suit our purposes; *its climate and locality among delta marshes would render it fatal to Englishmen*” (Pelley 1863: 621, emphasis added). While waxing poetic about the “clean, active town, with a broad and open main bazaar, and numerous solid stone dwelling houses stretching along the strand, containing 20,000 inhabitants” that was Kuwait, he notes only in passing that the exported horses’ forage, no doubt collected from the deadly delta marshes, “comes down the Bubiyan Creek from Bandar Zubair” (Pelley 1863: 619), while the exported dates, along with “a complimentary present of dates from Basrah in token of suzerainty and for the supposed protection of the mouths of the Basrah river” were actually received or shipped from the Shatt al-Arab (Pelley 1863: 620). Of Basrah itself, he wrote,

> it looked to me…like a blending of Nugger and Tatta in Sindh, the same outskirt of date trees and half-discarded canals, the same river fringing, the same irregular tumble-down piles of mud-brick houses…the same dirty picturesque children…the same wonder how the place ever got half built, and whether anything was ever new, finished, or repaired (Pelley 1863: 621).

In his report, Basrah’s exports were reduced to marginalia in tiny type, even though the value of the exported dates alone—dates watered by tidal flushing through those “half discarded canals,” and packed by the unnumbered parents of the “dirty picturesque children”—at “40 lakhs of rupees” (Pelley 1863: 621) was worth ten times that of *all* exports from Kuwait, valued at only “four lakhs of rupees” (Pelley 1863:

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[94] For rice, teak, boat masts, clove, coconut pulp, and coconut oil from Zanzibar, and

619). Basrah's real value, from Pelley's perspective, was not its commanding position in recruiting agricultural labor to harvest dates and collect fodder, but its position enroute to Baghdad along "any extension of the present steam communications through the Gulf" (Pelley 1863: 622). But against Pelley's marginal notation and denigrating description of deltaic terrain, a half-century later Mandate administrators saw a different landscape. They estimated that 75% of the world's date consumption was produced in Iraq, principally "in the neighborhood of Basrah, where the belt of date palms on either side of the river Shatt al-Arab has an average width of about a mile, and stretches from Fao to Qurna, a distance of 108 miles." By that time, their reports of agricultural production and export included wool, grain, pulses, oils, intestines (casings), hides, skins, tobacco, cotton, flax, hemp, liquorice, dried fruit, almonds, nuts, gum, gall-nuts, and silk—some of these in infinitesimal quantities, or merely expressed as hopeful possibilities. Despite this optimistic vision, agricultural production of fodder, fuel, and packing material remained nearly invisible. For example, in a government press book of that period, the photographic plates documenting date cultivation around Basrah clearly depict the reed mats and baskets used during date collection, sorting, local sale, and packing for export (Government of Iraq 1919), and in summarizing date export volumes, a report-writer notes that over half the annual total (about 60,000 tons) was packed "in baskets containing about 150 lbs" (Rush and Priestland 2001: 329–30). However, neither the total number, nor the origin, of the eight *million* baskets therefore required to handle that tonnage was noted.

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for long cloths, rice, coffee, planks, and spices from Malabar and Bombay.

It is not as if British troops and administrators bypassed (or passed blindly through) deltaic terrain. The first English East India Company factory was established in Basra in 1763, and thirty years before Pelley's report made its way to Bombay, the Chesney expedition had sought to commence mapping potentially profitable (and shortened) lines of communication to India from Turkey along the Euphrates and Tigris. This work paved the way for Sir Austin Henry Layard's 1841 expedition to Nineveh (even as border skirmishes along the Tigris brought the Ottoman and Persian empires to the brink of war). In 1847, the Treaty of Erzeroum appointed a Commission of Delimitation to lay down the frontier between them, from Baghdad to Muhammara (Khorramshar–Abadan). The attempt, carried out over the next four years, was mostly unsuccessful, but it did afford English archaeologist W.K. Loftus the opportunity to explore the ruins of Biblical Chaldea (such as Ur) along the lower Euphrates, and steamer traffic was regularized by the 1850s (Loftus 1856, Chesney 1868, McNie 1935: 6–8). And, as discussed in the introduction, by the turn of the century Ottoman modernizers had commissioned Willcocks' comprehensive assessment of agricultural "potential," given a hydraulic re-engineering of the delta and its wetlands (page 7, Figure 1). But British land measurement away from the rivers began in earnest only with the arrival of the Turco-Persian Boundary Commission in late 1913. As "the culminating act of seventy odd years of diplomatic *pouparlers*, special commissions, and international conferences between the four Powers concerned (Hubbard 1916: 1)," delegations representing the imperial governments of Turkey, Persia, Russia, and Great Britain were charged with demarcating the 1,180-mile-long international frontier, from Pelley's old post at Bushire (on the Persian Gulf coast) to Mount Ararat (in Armenia). Benchmarked to the previous century's Survey of India,[95] within a year—in an effort completed despite the onset of World War One—Indian Army surveyors accompanying the British delegation mapped the boundary between the Ottoman and Persian territories, and erected two hundred and twenty-three concrete pillars to commemorate the feat (Hubbard 1916: 1).[96]

Presaging Hall's journey to Ur six years later (Hall 1930), after traveling three weeks on a crowded Pacific & Oriental steamer from Marseilles, to Port Said (Egypt), though the Suez canal to Aden, thence Bombay and up the Indian coast to Karachi, with a change of ships at each port, Hubbard finally landed at the junction of the Karun with the Shatt al-Arab on 11 December 1913. After six weeks delay, spent outfitting the expedition and waiting for the Turkish and Persian delegations to arrive overland from their respective capitols, a cortège some 400-strong set out for the long trek to Ararat. For eleven months, the Commissioners, with their entourage of deputies, transport officers, engineers, medical officers, secretaries, clerks, surveyors,

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[95] Edited primary materials are published in Phillimore 1950–68. For a short, highly readable historical treatment see Keay 2000.

[96] This cartographic exercise became the foundational backbone for the British "T.C." (Tigris Corps) and final "I" (International) quarter-inch (1: 253,440) Fao–Baghdad–Aleppo map series. Begun by the Survey of India detachment's ground survey party at the outset of the British invasion at Basrah in 1914, rapidly expanded with the aid of aerial reconnaissance through out the war (with improvements and additions made by both British and German cartographic departments as terrain changed hands, it was finally completed in 1924 (see page 25; Table 1; for a detailed discussion see British Naval Intelligence 1944: 646–8).

masons, armed escorts (mounted on cavalry chargers shipped from India), and one Russian naturalist, were accompanied by a 230-mule pack-train bearing everything imaginable from tin baths to theodolites, including muleteers (mounted on local Arab mares), guides, batmen, cooks, launderers, grooms, cleaners, and personal pets (Hubbard 1916: 16–19, 26–32, 50–51; 94–95). *En procession* in full-dress regalia six hours per day through the outer delta, along the Luristan piedmont, up the Diyala valley, and through the mountains between Urmia and Van, “the caravan stretched for two or three miles across the plain” (Hubbard 1916: 94). While the surveyors went about the concrete business of the enterprise, the Commissioners were entertained by local dignitaries; the officers amused themselves by riding, hunting, and fishing, and the escort fended off occasional small raids.

Despite the best efforts to transport the Commissioners in a style befitting their dignity and the importance of their mission, “the degree of comfort or discomfort in the camp varie[d] in pretty direct ratio with goodness or badness of the water supply,” which was at times fetid, (for them) undrinkably brackish, or both (Hubbard 1916: 91). As their journey initially passed through the outer delta, across the Karun and Karkeh, and continued through “a huge tract of extremely fertile country, which a little labour in irrigating would make as productive as any in the world….watered by the scanty streams which come off the Eastern watershed of the Luristan mountains and flow down to the marshes which fringe the bank of the Tigris” (Hubbard 1916: 70, 76) it was not as if the marshes themselves, nor the towering reeds demarcating their borders, went unnoticed. Indeed, lead by the transport officer, provisions, forage, and mail were delivered weekly by parties from Amara, al-Gharbi, Kut, and Baghdad (Hubbard 1916: 96). Of the journey's outset, the British Commissioner's secretary remarked that:

> as far as Umm Chir the frontier could be marked on the map but not on the ground; for the reason that the first part of it runs through an arid

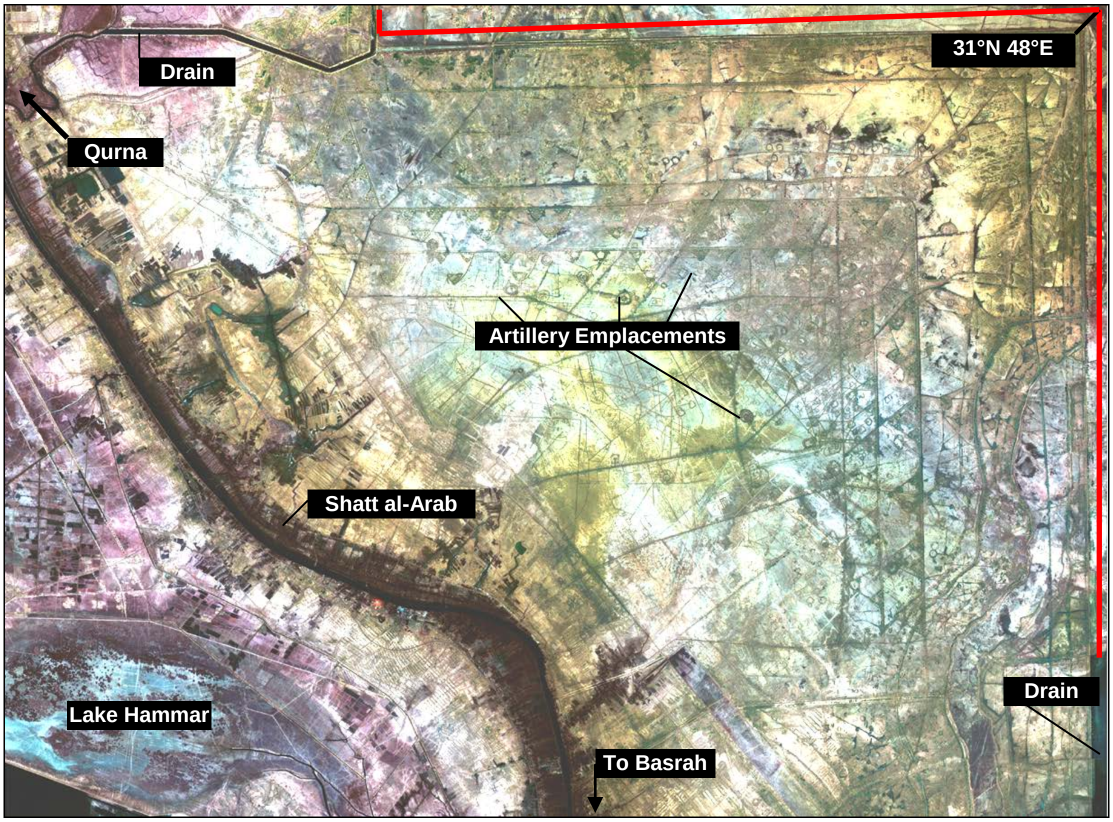

Figure 85: Iran–Iraq border (red). Drainage canals, border fortifications, gun emplacements, and minefields now demarcate a boundary of which Hubbard wrote in 1916: "there was…no need for [boundary] pillars even if it had been possible to erect them; so the frontier was made to follow convenient lines of longitude and latitude and left to look after itself" (Hubbard 1916: 58–59). Source: NASA (MODIS).

> desert too dry for travelers to pass through, the second part through an immense marsh (the Kor el-Azem) which is too wet. The desert and the greater portion of the marsh being uninhabited, there was, moreover, no need for pillars even if it had been possible to erect them; so the frontier was made to follow convenient lines of longitude and latitude and left to look after itself (Hubbard 1916: 58–59) (Figure 84).

Hubbard even separated from the grand procession to travel by boat for two days down the Karkeh and through its impressive wetlands. But his observations betray an incongruous engagement not unlike Pelley's. On the one hand, though charged on behalf of the Crown with fixing the boundary, he was unconcerned that setting benchmarks along its actual course through the marsh was impossible, since nobody lived there. Yet, in his trip diary he describes Bisaitin (Bostain), "one of the biggest of the marsh villages," which stretched along the lower Karkeh,

> as a single row of huts for miles along each bank of the river, with side streets at intervals on canals leading off the main stream. The huts are long and narrow, the walls consist of bundles of reeds about six feet high, partly sunk into the ground and covered with a barrel roof of reed mats…Each village has one or two mud palaces where the big-wigs live…For an hour we slipped past an endless succession of reed-huts, and crowds of staring Arabs and naked children lining the bank…(Hubbard 1916: 72–73)

In form and extent, Bostain would have been comparable to Suwaich, west of the Tigris (Figure 66, Figure 80), or to ech-Chubayish on the Euphrates (page 171, above; Figure 85). During the 1950s, though much reduced following the war and several destructive floods, the population of the latter alone was still estimated at nearly 11,000 (Salim 1962: 21). Deeper within the eastern marshes, within a few kilometers of that convenient line "left to look after itself," a score of nucleated towns like Turaba each covered 5–15 hectares of built-up area (Figure 67, Figure 70), with innumerable

Figure 86: Ech-Chubayish, along the Euphrates north of Lake Hammar. In this false-color image, green reeds appear red. The name means “place of built islands”; in 1959 access was solely by water. As drains emptied the lake, the town was left high and dry. LANDSAT 1991.

hamlets, similar to that shown at Figure 72, of a hectare or two apiece in extent delimiting the deep-water reed beds—not to mention various temporary camps and floating platforms within the lakes themselves. None of this went unnoted by Hubbard:

> The marsh scenery is wholly unlike anything I have seen elsewhere, and hardly less unique is its population of queer amphibious beings who live among their swamps, isolated from the outside world, and earning a meager livelihood by growing rice and fishing…(Hubbard 1916: 71–2).

Nor did the reeds themselves evade his view:

> The boats we meet coming up-stream [are] loaded with cut reeds….The Kerkha abruptly came to an end amidst impenetrable reeds…but the marshmen turned out in force and pulled…us over a bar into a hidden canal about five feet wide and full of other *belems*…we…are now meandering along a vague channel among the reeds….only a few feet wide, with a sharp turn every few yards, and an impenetrable wall of rushes six feet high shutting us in, so that all one can see is the sky and a few yards of water ahead and behind…we…came out into a lagoon thick with waterfowl…waded ashore through the shallows and came on a mile into camp.” (Hubbard 1916: 74–75).

But, even though his diary of this "lazy progress down the stream," betrays a blissful romantic engagement:

> After lunch and a shoot on the bank, which is full of francolin and hares, we are again paddling…The river banks are populated by innumerable tortoises, who sit and crane their necks as we go by. There are solemn cranes standing sentinel here and there, and kingfishers…flitting over the water (Hubbard 1916: 72).

in the end, the prevailing view with which he had arrived, like a ritual litany, won out over his own observations at the time:

> The main features of the country can be summed up in three words—river, desert, and marsh, the river being, of course, the essential feature. The "Waters of Babylon," which once made Mesopotamia a rival with Egypt for the title of the "World's granary," still keep their fertilizing powers intact. But the old dams, canals, and barrages are gone, and the productive land is now narrowed down to strips of palm groves fringing the river banks. Where the palm groves end the desert abruptly begins. There is nowhere that 'Strips of Herbage strown, That just divides the desert from the sown,' where old Khayyám invites us to wander in blissful oblivion (Hubbard 1916: 35).

Within a paragraph, a countryside summed up by the three words "river, desert, and marsh" is diminished to an essentialized "productive" palm-fringed river, abutting desert waste.

During the ensuing war, the marshes themselves—posing, as they did, a potential barrier to the movement of troops and war materiel—became the express object of military surveyor's scrutiny (see page 25, note 96). But beyond the useful cartographic depictions of flood basin boundaries, marshy zones, and lake depths (with seasonal variations), the Army camera's eye recorded further aspects of that terrain not explicitly included in the administrative landscape (Table 16). Along the Tigris from Kut to Basrah, incidental to river and camp views (including the axel-deep

Table 16: Selected British Army Photographs Depicting Marshes and Reeds, 1915–19

LOCATION	CAPTION	ILLUSTRATION	*SOURCE
		Marshes and wetland pastures	
Kut–Amara	View of Tigris	Reed marsh	Q27325
Kut–Amara	Mahaila on the Tigris	Reed marshes	Q49785
Kut–Amara	Suwaiqiya Lake or Marsh	Marsh stubble	Q71328
Kut–Amara	Artillery battery	Floating guns and limbers across marsh	Q106217
Kut–Amara	Troop camp	Pastures, reed village	Q71327
Kut–Amara	Troop camp	Limbers ankle-deep in mud	Q71324
Kut–Amara	Bullock wagon	Ankle-deep in mud	Q27324
Kut–Amara	Photographer’s car	Axel-deep in mud	Q24528
Amara	Fahala Creek “flows out of the Tigris and disappears in a marsh”		Q27334
Qurna	Brick kilns	Stabilized road bed along marsh rim, desiccated marshland	Q24210
Qurna	Entrance to Euphrates	Reed marsh	Q27303
Qurna	Ft. Snipe at Tigris bend	Reed marsh	Q60255
Qurna	Bedouin skin tents	Marsh grass pasture	Q24218
Amara–Qurna	Qurna–Amara railway	Desiccated reed-bed	Q25661
Basrah–Ma’qil	Marsh Arab reed village	Bulrush pastures	Q15337
		Reed Construction in Villages	
Amara–Qurna	Woman spinning	Reed house walls, mat roofs, bundle doorposts, scattered fodder or flooring	Q25662
Basrah–Ma’qil	Riverside dwellers	Reed bundle houses with reed mat roofs	GOI
Basrah–Ma’qil	Marsh Arab reed village	Reed cattle byres, kilns	Q15338
		Reed Constructions in Towns and Cities	
Kara Tepe	Troops entering	Reed roof filler	Q24513
Baghdad	British troops, 1917	Reed mats in roof fill	Q24168
Baghdad–Tigris	Troops cross Kotah Bridge	Reed mats in roof fill	Q24172
Baghdad–Tigris	Lower bridge of boats	Reed mat bumpers, willow gufa	Q27343
Kut	Sappers having meal	Reed mat awnings	Q27320
Amara–Qurna	Arab village	Reed byres, lean-tos alongside mud-brick buildings and palm groves	Q27292
Qurna	Scene with cobbler	Reed bundle posts, mat awning, basket	Q25695
Qurna	View	Reed-walls, reed thatch warehouses	Q25664
Qurna	View from river	Reed mat quayside awnings	Q27294
Qurna	Mahailas on river	Reed mat quayside awnings	Q27300
Nasiriya	The Sisters’ Quarters	Reed mat awnings on upper balconies	GOI
Basrah–Ashar	Ashar Creek	Reed mat quayside awnings	GOI (X3)
Basrah–Ashar	Opposite IWT docks	Reed mat quayside awnings	GOI
Basrah–Ma’qil	IWT Craft re-erection yard	Reed mat screens, roof shades, and shades	Q15304–6
Basrah	Date factory	Reed thatch, matting	GOI
Basrah	View from roofs	Reed mat beds, lean-tos, roofs; thatch	GOI
Khorramshar?	A Model Dairy	Reed mat roof, woven reed walls	GOI
		Reed and Rush Products and Packing Materials	
	British artillery	Reed mat sun shades	Q24343
Babylon	Girl winnowing	Rush winnowing tray	Q24839
Amara–Qurna	Women selling fruit	Rush basket	Q24186
Amara–Qurna	Bellum at Ezra’s Tomb	Reed punts	Q24571
Amara–Qurna	Reed craft	Barge of reed mats	Q25646

Qurna	Women washing, cleaning and drying fish	Reed mats, punts, scaffolds, bundles; willow baskets, poplar poles	Q25715–9
Shatt al-Arab	Hospital huts	Reed mat awnings on boats	Q27331
Basrah–Ashar	Loaded bellums	Reed: rolled mats, packing, bundled	Q24592
Basrah	Robat Creek	Reed mat awnings on boats	GOI
Basrah	Date collecting	Reed mats, baskets	GOI
Basrah	Date sale	Reed baskets	GOI
Basrah	Date packing	Reed matting	GOI
Basrah	Zahroon, a silversmith	Reed mat flooring	Q24601
Basrah	Potter and wares	Stacked reed mats, rush shipping baskets	GOI
Basrah	Grain merchant	Reed mat shade, reed baskets	GOI
Basrah	Bread vendor	Reed oven fuel (bundled), reed baskets	GOI

*GOI: Government of Iraq 1919. Q#: Imperial War Museum Mesopotamian campaign 1915–18

mud of areas subject to seasonal inundation) were miles-wide vistas of reed marshes and wetland pastures; of roads and lines of kilns ringing marsh rims. Photographs recording the novel reed villages clustered among Basrah's date palm groves more-or-less directly illustrated reed house walls, reed mat roofs, reed bundle doorposts, reed scattered as fodder or flooring, reed cattle byres, and reed stacked to fuel kilns. But triumphal records of British troops entering Baghdad, views along docks and quaysides, and snaps of artisans at work in towns also showed ubiquitous reed construction in towns and cities, including: reed mat bumpers on bridge piers; reed roof thatch, reed mats in roof fill, reed mat roof covers and shades, reed-mat and woven reed walls, reed-bundle door and support posts, reed byres and lean-tos alongside mud-brick buildings and in palm gardens, reed sleeping shelters on rooftops, and reed mat screens, shades, and awnings on storefronts, upper balconies, and quaysides. Reed and rush baskets and winnowing trays, reed mat sun shades and work surfaces, reed poles used as punts and scaffolds, reed bundles and mats stacked and rolled for transport, and an entire barge constructed of reed mats populated this working public sphere.

A unique set of records, keyed to and annotated upon the very maps that they helped to refine, show that British Army logisticians well-understood the potential centrality to the Ottoman war effort of the reed beds on both sides of the Tigris between Kut and Amara, and not just in terms of their barrier to mobility (Table 17). Sent aloft to record troop movements, supply bases, and potential for provisioning, for nearly a year Royal Air Squadron observers recorded, often meticulously and nearly daily, the locations of thousands of reed shelters, sheep, cattle, and stacks of “boosa” or hay made of primarily of reeds, opportunistically mixed with rushes and other wetland grasses, as well as agricultural activities and grain harvests.

Summarized at Figure 86, these observations document a cycle of agro-pastoral production, centered on Kut at the head of the inner Mesopotamian delta, wherein the marshes and their products are central, not peripheral, to agricultural life. In early January, rain waters flooded Lake Suwaiqiya; later that spring water poured through Tigris flood splays, inundating wetlands to the south such as Sa’adiya marsh (Figure 23) and Lake Gussab, which also received high water outflow from the Shatt al Gharraf. By late May, when detailed records begin, clusters of 20–100 reed mat “shelters”—some of these substantial constructions up to 70 m^2—lined the shores of lakes and marshes varying in diameter from “only” a kilometer, to the 250 km^2 sheet of water that was Lake Suwaiqiya itself. The shelters, and their accompanying flocks remained permanent fixtures for months on end. Two similar populations and settlement schema may be distinguished; the first, and ongoing, activity undertaken by both was “boosa” harvest.

North of Lake Suwaiqiya, (Figure 86: 1) grain planted along the alluvial fan

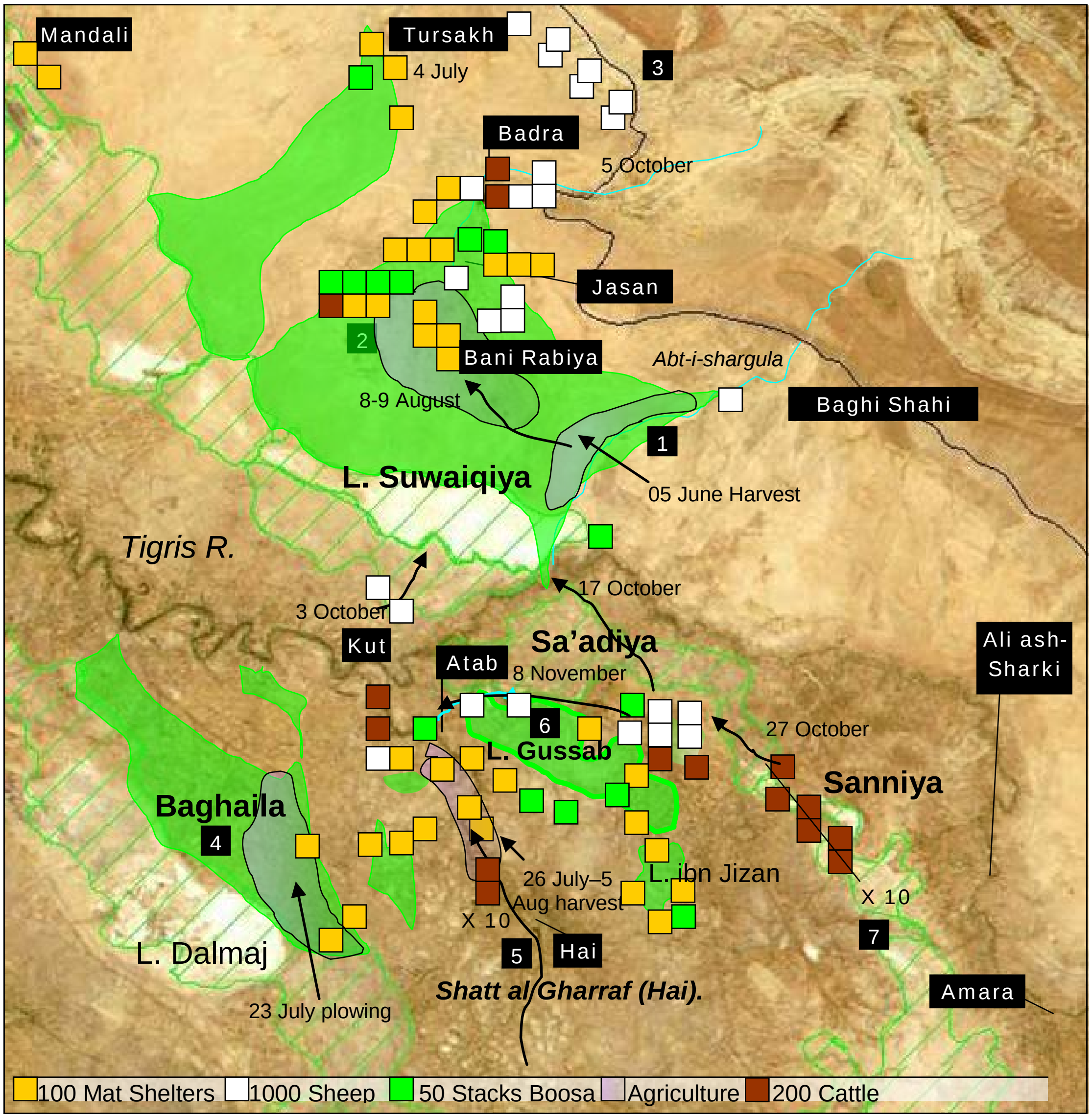

Figure 87: Air observations over Kut–Amara marshes, May–December 1916. Thousands of reed mat shelters and sheep cluster in this landscape. Production zones may be grouped into two similar settlement schema north and south of Lake Suwaiqiya. See page 232.

southwest of Baghi Shahi was harvested in early June and piled in stacks for several miles along the riverbank. However, this activity ended as quickly as it began. Thereafter, (2) as the waters of Lake Suwaiqiya receded, plowing in the soggy basin began in early August. Thousands of sheep grazed the marsh's north rim, while intensive boosa harvest continued. By early October, (3) thousands more sheep begin moving down the piedmont, grazing their way toward the late summer pastures left by the receding waters.

South of Lake Suwaiqiya, (4) east of the Shatt al Gharraf (Hai), in late July as waters receded around Baghaila marsh, the basin edges were plowed and planted. From late July–early August, (5) grain was quickly harvested along the Shatt itself between Atab and Hai, and grain harvested from surrounding areas was moved to threshing floors there. Thereafter, thousands of cattle from more southerly wetlands were penned in the drying riverbed. (6) Boosa was intensively gathered around Lake Gussab and surrounding marshes while several thousand more sheep grazed its northeast rim. As flows through the Gussab canal dropped, sheep also grazed the canal bed. In mid-October, the flocks begin to split up, spreading northward across Saadiya marsh, across the Tigris to the south shores of Lake Suwaiqiya, and along the north rim of Gussab toward the Shatt. By late October, (7) 12,000 cattle moved north along Sanniya marsh into the Gussab basin.

It is important to note that what cultivation took place was not dependent upon irrigation engineering, except for some channeling of the alluvial fan. Farmers clearly took advantage of the high soil moisture available from flood basin recession, but a minimum of work went into planting , harvest, and threshing; a maximum into boosa harvest. It is also important to note the territorial fixity of the settlements and flocks. Clusters of up to 5,000 sheep, in flocks of 500–1500 animals (along with a few hundred cattle), grazed within single basins for up to half the year, in addition to which thousands of stacks of boosa were stockpiled. The “shelters”—if not, indeed, permanent villages—were stationary throughout this period. Only during the brief harvests, as grain was stacked and threshed along the Shatt and Abt-i-shargul, were up to several hundred smaller, temporary mat shelters, in clusters of 20–50, added to these work areas; they as quickly disappeared. Although not recorded by the air observers (who were intent on movement of materiel), later photos show many mud-brick villages in the same areas as where these reed shelters clustered, along with a mud fort near each flood basin. Except around the smallest, most temporary basins there is no appreciable change in the number or distribution of reed dwellings—not even when, in autumn, the residents were joined by pastoralists moving 7,000 sheep south from the piedmont into the Suwaiqiya basin, and 17,000 cattle north into the Shatt and Gussab.

And yet, this direct military experience was not fungible across institutional boundaries. As noted in opening this chapter, civil administrators may have been willing to toy with the profit potential of mulberries and silk worms, but there was no place in their landscape for a marsh-centered view. Kut was, to them, a locus of military failure, bombed to rubble, dusty in summer and chocked with mud in winter, where besieged troops had starved in sight of plenty. Fed by an archaic and inappropriate agricultural scheme that did not include technocratically-engineered, surveyed, irrigated, and properly cultivated croplands, it was for the moment best forgotten. The reeds that had produced every strand of wool, bowl of yoghurt, and spit of meat so desperately craved by their own troops lay utterly beyond their ken. At the war's end, one of the first endeavors of civil–military affairs officers was to invite the dignitaries of Amara and Basrah to a proper, British livestock fair and show, where sepoys displayed the massive, "improved" specimens of sheep, cattle, and horses bred in India alongside "model" practices of farriery, dairy herd management, and cart drayage turnout. Grandstands were erected for thoroughbred horse races and an air show. Separate classes and races were organized for desert Arab horses and camels, and the entire event was commemorated with a glossy book of photographs showcasing the region, which ran to several editions (GOI 1919).

Within two decades, the first-hand knowledge gained at Kut and Amara seems even to have dropped from the military sphere. Although chronicling the 1915–16 campaigns to capture those cities, and elsewhere noting camel thorn, lentils, and even date stones (!) as sources of fodder, the nearly 700-page thick 1944 Naval Intelligence Division Geographical Handbook to Iraq—a masterly compendium of maps, photographs, statistics, history, ethnography, economic studies, and the like that still stands as a basic reference for the delta and Gulf—includes only one index entry for reeds: "used by the Arabs for their huts. It is easy to become lost in these marshes; the solitude is intense, there are few landmarks, and the *mashuf* leaves no track…". (NID 1944: 64, 187, 458, 461, 277–79).

The romance of the seeming remoteness of these reed beds south of Amara must have been acutely felt by local British officials. Two of these, writing pseudonymically as "Fulainan," relate time spent in the company of one Haji Rikkan

(Hedgecock and Hedgecock 1927). Rikkan became an agent supervising cultivators sent by Salim al Khaiyun, a Muntafiq sheikh seeking to extend clan holdings from their stronghold on the lower Euphrates northeastward into the western Tigris marshes, where tremendous profits were to be had growing rice. British Administrative Journals record that "Salim's only object in thrusting a few undefended cultivators into [the Albu Mohammad lands of the Amara] Division [from Nasiriya], could have been to attempt Sikar into making an attack of which he could take advantage," and, eventually, a skirmish did occur, "with a few casualties on both sides." [97] Such was the administrative view from the perspective of Amara; the Hedgecocks romanticized this story, portraying Rikkan as a simple canoe-peddler, caught up in forces beyond his control, in a tribal war set off by the dislocations of World War I and waged in the personal terms of tit-for-tat revenge killings and fierce contention for every small patch of muck extending above the waterline. This tale was the first of several attempts by British observers to chronicle marshland life-ways, but it did so in a manner that did not make apparent to the reader the specificity of what was described. As a morality tale of clan and tribe, *set* in the reed-, buffalo-, and-rice-land of the marshes southeast of Amara, it seemed to stand for all those who lived away from the substantial towns and cities of the lower Tigris. Several decades would pass before more, and more scholarly, studies laid out practices and products in other wetland ecotones (see Table 18, Figure 87).

The Hedgecocks had even noted Rikkan's own keen sense of taxable

[97] British Administrative Report Amara 1919, cited in Westphal-Hellbusch and

marshland produce moving along the Tigris—at one point, Rikkan was appointed as a sergeant in command of six men at Kassara, near Qalat Salih,

> just where a stream of clear blue water from the marsh flows into the Tigris…Opposite the mouth of the stream stood Haji Rikkan's mud fort, or rather his toll bar; for no *danak, birkash, mashuf, torrada,* or *challbiyah*[98] did he allow to issue from the marshes until its owner had paid a tribute. If it was bringing fish for sale, the Haji demanded a fifth of their value; reeds, feathers, mats, wild-fowl, all were estimated by his ruthless eye, and on all the toll was levied."(116–117)

But, as noted, British agricultural administrators were otherwise preoccupied. Not until the 1950s would a British-trained social anthropologist, originally from Amara, in a classic study of one town on the lower Euphrates, put reeds and mat-weaving at the center of the local economy, and relate the reed harvest cycle to livestock production, mat sales and canoe trading with entrepreneurs from Nasiriya and Amara, and annual labor migrations to harvest grain along the Shatt al-Gharraf, pack dates in Basra, and fish in Lake Hammar (Salim 1962).

Salim himself is very careful to note that he deals specifically only with the lower Euphrates delta; that not all inhabitants are Ma'adan, or deep-water buffalo breeders; nor are all inhabitants Arabs, or, if Arab, necessarily affiliated with desert-based tribal heads. He particularly notes that, for town-dwellers, "Ma'adan" is merely a perjorative referent to any non-urban person, that is, any "hick" from beyond the civil pale. By deconflating the images and terminology attaching to essentializing terms like "Ma'adan" and "Marsh Arab"—too often used interchangeably, and

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Westphal 1962: 106–7.
[98] Types of local watercraft.

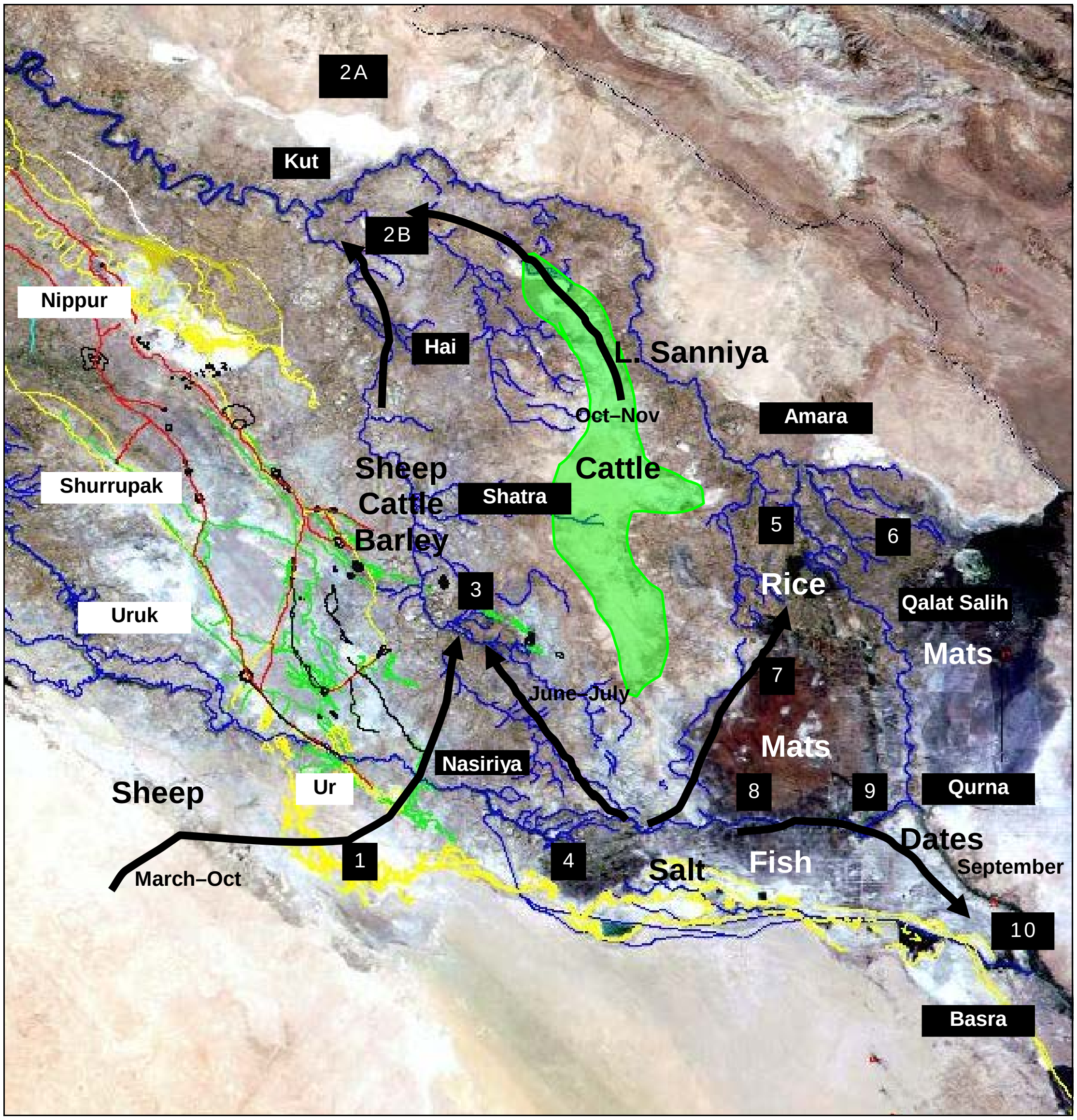

Figure 88: 20th-Century Geographies and Ethnographies of the Tigris–Euphrates Delta. 1. Late winter rains flood the Ur basin; pastoralists from the Arabian shield graze flocks on spring pastures, crossing the Euphrates and on up the Gharraf after May floods. 2. See Figure 86. 3. Mid-Gharraf barley cultivators keep flocks for carpet production, exchanging these for cloth produced by pastoralists who arrive in October to graze receding lake pastures. 4. Residents of the southern Hammar belt produce salt and fish, migrating in September to Basra for the date harvest, and up the Gharraf and to the Amara districts for the winter grain harvests. 5. Rice cultivation and buffalo breeding is–for the town-dwelling sheikhs who control it–extremely profitable southwest of Amara. 6. True Ma'adan–breeders of water buffalo–inhabit the deep-water marshes to the south and southeast. 7. Following WWI, competing attempts to extend rice cultivation along the prograding delta resulted in clashes near Saigal. Thousands of cattle graze Lake Sanniya's reed pastures, moving north in late October to graze the riverbeds at low water, and to market at Kut. 8. Ech-Chubayish, at the transition from inner to outer delta, straddles several agricultural economies. 9. Cattle graze salt pasture near Qurna; residents maintain palm gardens. 10. Dates, watered by tidal flushing, are packed and shipped from Basra. See Table 18.

universally, to describe all wetland inhabitants—Salim's study makes possible a more integrated picture of the productive zones of the inner and outer deltas, built from more particular (and more general) studies. Such a picture is extremely important for completing a reconstruction of lower Mesopotamian landscape of 4000 BCE.

The wetlands of the southern delta may be broadly divided into several distinct zones. In all of these, the predominant activity is reed-cutting for construction, fodder, fuel, basketry and reed matting produced for barter or sale. The harvest cycle begins in January, when soft growing rushes emerge near the settlements and are cut for cattle fodder; this continues through August, following new growth ever-further from the permanent communities. In mid-August, though still green and soft, some reeds have matured sufficiently to be cut for mats; their leafy portions also serve as sheep fodder, and reed-seeking begins in earnest. Reed-cutting and mat-weaving continue through November. By December, the reeds, now thick, yellow, and dry (called *jinuba*), are at their prime for mat-making. Come January, fodder may once again be sought close to home, but *jinuba* is available farther away, and people may migrate to islands deeper in the marsh to continue its harvest. By the time reeds are 18 months old, they are too tough for mats, but ideal for fuel. Thereafter, left to themselves reed stands become increasingly tatty and wind-battered; reed-beds are at this point burned off to accommodate new growth. In general, men do the cutting and weaving, while women and children measure, tie, and bundle reeds according to length and stem thickness (Salim 1962: 105).

Only the true Ma'adan–water buffalo breeders –dwell permanently in the deep-water marshes and lakes to the south and southeast of Amara (Thesiger 1964, Maxwell 1957, Hedgecock 1927). There, their inaccessible, floating dwelling platforms, constructed of reeds and muck to give nightly haven to their animals, were at times a place of refuge for those fleeing predatory sheikhs and various government officials. To the southwest of Amara, rice cultivation and buffalo breeding is—for the town-dwelling sheikhs who control it—extremely profitable, and following WWI, competing attempts to extend rice cultivation along the prograding delta resulted in the clashes near Saigal (Westpahal-Hellbush 1962). But a more traditional occupation on the western marsh rim is cattle-breeding. As discussed above (page 232), thousands of cattle graze the seasonal reed-beds surrounding Lake Sanniya, moving north in late October into the low-water riverbeds, and, in some cases, to market at Kut.

A second annual transhumence is associated with the recessional pastures along the Shatt al-Gharraf. After late winter rains flood the Ur basin; pastoralists from the Arabian shield graze flocks on spring pastures, crossing the Euphrates to head up the Gharraf after May–June floods (UK NID 1944). Mid-Gharraf barley cultivators keep their own herds and flocks for carpet production (Wirth 1962), exchanging these for cloth produced by pastoralists who arrive in October to graze receding lake pastures. Because this arrival of thousands of sheep from the south significantly stresses emergent grasses, the bulk of the barley harvest is used for supplemental sheep fodder over the winter (Ochsenschlager 1993b).

At the the Tigris-Euphrates junction near Qurna, levees are sufficiently developed to provide a belt of salt grass pastures, used by nomads to graze cattle. The (slightly) heightened levees create a well-drained root zone, enabling settled communities to maintain palm gardens, with vegetable crops grown in the understory (Westphal-Hellbush 1962). A line from Nasiriya to Qurna demarcates the northern border of the Hammar marsh belt, where the Euphrates bed is lower than that of the Tigris, and hence receives water drained through the Tigris marshes. Its southern boundary lies at the transition between the inner (fresh) and outer (estuarine) deltas. Here, residents produce salt from deep wells, and fish from Lake Hammar (Salim 1962: 19). Finally, the tidal flushing that sends twice-daily surges into side canals waters thousands—at one time, over a million—dates palms along the Shatt al-Arab as far as Basrah, where they were packed and shipped for world export (Wirth 1962). Southeast of Basrah, to the Gulf at Fao, smaller communities grazed animals on salt pasture, erected miles of fish-traps on the mud flats and smaller estuarine streams, and sailed down the Gulf for fishing and shell-diving (Hassan and Criddle n.d.: 2:59–7:33). Ech-Chubayish, like other communities of the Hammar belt at the transition from inner to outer delta, therefore straddles several agricultural economies. Its 1,600 man-made islands were often too wet to maintain palm gardens, though some were kept with variying success. To supplement their diet (if not their income), many residents migrate in September to Basra for the date harvest, and in winter up the Gharraf and to the Amara districts for the winter millet and rice harvests. But these activities must be (and are) viewed as supplementary; in 1952, 862,000 reed mats were produced by the 11,000 residents of ech-Chubayish alone. “had it not been for the reed, all the people would have left” (Salim 1962: 94, 108–109).

As shown in overview at Figure 88, to complete the picture laid out in Chapter Four, this productive system may with some success be mapped onto the Uruk countryside. At 4000–3000 BCE, this is a younger delta; a smaller delta, compressed by rising sea levels, and without the conjoined input of the Kurun. The rivers' placement, as we have seen, is only approximate, but sufficiently known to delineate fresher (more blue) and saltier (more green) zones of inundation. The winter cattle pastures at the head of the inner delta north of Hai (Figure 86) may be compared to flood basins formed below nodes of avulsion above Nippur (Figure 87), with, for example, Shurrupak corresponding to Hai on the Shatt al-Gharraf. The cities—such as Umma—clustered at the Karkar splay then lie in a setting similar to that of Amara, but much closer to the salt pastures of the lower estuaries. The transition zone from the southern Hammar belt to Fao on the Gulf coast may be compared to the transition zone south and east of Warka, with Uruk in the position of Qurna (or, through time, Nasiriya) and Ur in the position of Fao or, in time, Basra. While coring would be required to establish definitive boundaries for salt and fresh marshes, as discussed in Chapter Four the direction of water flow, in conjunction with natural boundaries reinforced by the accumulation of substantial southeast-trending levees, probably resulted in a belt much like the Hammar district in the Eridu basin, with tidal flushing as far inland as Uruk.

As we have seen, the preceding Ubaid periods, and especially the Ubaid 2/3–4 (pp.184–191), were all about rising sea levels. This was a slow progression, lasting on the order of two millennia, with a lot of intermediate variation, especially during the

Ubaid 2/3, when fishing camps such as that at H3 (Figure 34 and ff.) trading with appeared all along the Gulf coast. As sea levels rose through ‘Ubaid 4, the lower delta no doubt comprised many little “Bubiyan” and “Falaika” islands with fish traps in the flats. Certainly we see a slow consolidation of institutional structures on turtlebacks above the flood, with an emphasis on storing dried fish. At the sea level maximum, the lines of communication opened by earlier fishing routes had been carried all the way to Ur’s doorstep. [99]

As discussed above (page 191), while sites become increasingly visible from the Early Uruk onward, we still know very little about the period. Nevertheless, the site distribution we can see suggests a visible reliance on reed pastures in the Dalmaj basin, and (probably mixed reed and salt) pastures at the head of the Warka basin. It also suggests the increasing importance of control of the avulsive fans that are the gateways to these environs. No doubt this will one day prove true at Warka; other locales, such as the node south of Shurupak, may prove to carry less overburden and be more amenable to excavation.

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[99] Several measures could be taken to test this notion. As I indicated in Chapter Three, the old shoreline should be examined with higher resolution imagery, and a ground inspection done to determine precisely what phenomenon is detectable on MODIS. Because Roux’s only survey of the Hammar district was undertaken at a time when traficability made examination of all but the most visible mounds possible, a new survey along the old shoreline, with the express aim of locating Ubaid sites, should be undertaken. The new highway, which runs parallel to this line, should provide good accessibility. Obviously, additional cores taken from within the Warka and Eridu basins would be highly desireable; absent this, analysis of any extant unbaked mud fragments from early strata for phytoliths and other residues would help establish the prevalence of hydrophytic or halophytic plants. Finally, much might be learned from further examination of sickles for plant residues, and to establish periodized typologies.

But from the Late Uruk, our visualization of this landscape is aided by the imagery and ideograms used by an emergent class of increasingly professional administratiors (see page 201). Commodities tags included fresh fish (Englund 1998: 60), and among the most frequently used Uruk IV-III signs, along with cattle are dried fish, fresh fish, snake, pig, and bird (Englund 1998: 70-71). Fish are noted in as many Uruk III texts as cattle (Englund 1998: 88). In a toponymic representation of the outer delta, an ideogram for "sea," in the form of a fish trap, becomes associated with both household and ten city names, including Ur (with reed finial), Larsa (with sheep), and Uruk (filled with hachures) (Englund 1998: 69, 81, 91, 93). The ideograms for a number of other cities included reeds, bitumren-coated reed mat doors, and reed finials, while archaic signs for temple households included reed houses with attached reed finials or the finials alone with various attached standards, which seem to have represented city gods and, specifically, Inanna (Steinkeller 1998). Administrators (*En*) were represented by more substantial, long reed buildings with high-peaked fronts (and the finials) (Englund 1998: 69, 91, 102). Cylinder seals depict a plethora of reed byres with emergent livestock (Amiet 1960: pl. 17). Reeds are often depicted with hunting scenes, especially with wild pigs (Amiet 1961: pl. 40 no. 609; Englund 1998: 45). And, as mentioned above, direct evidence that reed mats were produced even then is their impression on the backs of gypsum and clay tablets (Englund 1998: 51, fig 14; Boehmer 1999).

In this landscape, livestock grazed on spring and summer salt pastures at the marsh rims would have moved northward toward Shurrupak and Nippur in autumn.

While cattle certainly were not new to the landscape, it would seem that cattle-keepers gained ascendancy over the interests—or representations—of fishers. The basis for this flourishing dairy-and-wool production was not, however, irrigated agriculture: it was mastery of the productive potential of the wetlands, and other glyptic representations reinforce the sense that Uruk elites were well aware of this dependence.

The most blatant expression of this is the so-called Warka vase, recently (and thankfully) recovered in Baghdad. At its bottommost tier, encircling the vase, lies water. Above this, a prominent circle of reeds. Then, a band of sheep and cattle. Above them, a band of naked men bearing filled bowls. Finally, surmounting this hierarchy, the en in his skirt, and more bearers and retainers, meeting the goddess Innana, represented by her two reed bundles. Or, again, on a cylinder seal, as big as a man's two thumbs, carved on soapy Euphrates limestone, an inch-high montage was carved depicting a new vision of authority. Eyes forward, seeing beyond the high prow of his canoe, accompanied by a spear-fisherman a man wearing a net skirt, ostensibly the *en,* is poled though towering reeds by a second, naked man. His image is surrounded by stacked accoutrements: a cow statuesquely posed; beside her, a pair of storehouse doors; on her back, an altar. Surmounting this is the reed bundle finial used to demarcate households and gods. As a human bridge from fish to cattle; a fisher of men bearing cattle, storehouse, and altar, carved into the stone (obtained across the water) used to build the white temple at Uruk, one cannot help but imagine him posing the question: "What if we looked at the world as one giant farm field?"

But the question, stripped of its European wasteful/useful dichotomy; stripped of turn-of-the-century prejudice against wetlands, carries variant intonations. I must first explicitly emphasize that the shift in temple offerings from fish to cattle and dairy products of itself shows a remarkable remaking of ideology: it is as great a change as the shift in the later Roman realm from reading a sheep's entrails to passing wine and bread. But what is revealed in the suppression of fish from the archaeological record, concomitant with an emphasis on dairy herds in the epigraphic record, is not an explicit recognition of that shift and its importance. Instead, it reflects a peculiar kind of empathy of the excavator with imagined ruling and administrative classes. The envisioning of Uruk (large and small) cattle barons risks echoing European reception of the peculiarly American vision that captured generations of imagination from the 1920s to the 1960s. Hollywood's representation of an egalitarian cattlemen's code as the successor to a putative egalitarian expansion across the American West—a "cattle culture" deemed alien to European urban experience—nonetheless came in some sense to stand for that experience. By a kind of hat-trick, the cattle-political experience of a moneyed elite was universalized as total experience, and cattle wealth (or lack thereof) became linked to cattle finance. To characterize the "style" or hallmark of a civilization as cattle-political, assert that the civilization does not exist until the arrival of cattle-lords, and thus conclude that conditions imagined to be hospitable to cattle must pre-exist their arrival, is to construct a tautology that neither fully investigates nor accounts a complex social experiment.

This criticism is not a cultural materialist one: quite the opposite, and it hinges upon the very definition of urbanity and civil-ization, as opposed to complex, ranked, differentiated, but somehow not quite urban towns. We might well first ask: What is a city? Although much hyped in poplar discussions ("bigger than Classical Athens"; "unequalled until Rome at the peak of empire"), size of itself is a poor measure. Four hundred hectares may represent the urban cradle of Western philosophy; it may also represent the dust-choked streets of modern Shatra. Both have religious, political, administrative, domestic, warehousing, market, and harbor precincts interconnected by planned roads, congested alleys, and engineered waterways, but they hardly conjure the same image of urbanity.

While, from the late fifth millennium BCE onward, throughout Mesopotamia urbanizing tendencies become apparent, even estimating city size poses considerable difficulties. First is that of contemporaneity. Periodic habitation of extra-urban environs tends to build up broad, shallow, overlapping horizontal deposits that can mimic urban sprawl. Second is that of determining what portion of the urban catchment–including suburbs or near satellites–to include within the "city" boundary. Extramural suburbs and satellites of late-fifth–early fourth millennium BCE Syro-Anatolian cities are often included in total area estimates even where discontinuous or, if continuous, comprising a number of discrete mounds quite different in plan from later cities of the southern alluvium. Lastly is the difficulty of ever recovering these environs. *Least* amenable to recovery are shallow sites (including suburbs and satellites of large, deep urban centers) situated at points of effluence where rivers emerge from deeply incised channels into alluvial fans and floodplains–as for the upper Tigris–Euphrates alluvium. These become quickly and deeply buried under deposits of sufficient thickness that they are unlikely to be revealed by later deflation of the plain surface. Early sites, and especially early, shallow, extra-urban deposits, are only rarely recovered at all from the heavy sediments of the northern alluvium, and where recovered are not included in site area totals unless dense, contiguous, and apparently contemporaneous with urban cores.

More important than size to urban definition is boundary definition, or, rather, hinterlands definition. That is, somewhere outside the conceptual borders of truly urbanizing zones—even very small ones not enclosed by city walls—exists a landscape that has become subordinated to supplying urban needs, even at the expense of its own. Mapping such a landscape vision onto an imperfectly visible, and no doubt imperfectly visualized terrain is obviously problematic. Nevertheless, in this sense, a study of Uruk period marshland resource administration is by definition not a mere addendum to a better-studied agro-pastoral irrigation economy. The managerial origins of later irrigation hydrostrategies were *a priori* dependent upon a wetland landscape that endured in various forms for seven millennia, and one that only during the twentieth century CE finally was dammed, diked, distributed, drained, and managed to extinction.[100]

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[100] From 1976–2000, at least 7,600 km^2 (85%) of the *permanent* wetlands in alluvial Iraq disappeared, partly as a result of hydroelectric flood control and irrigation projects on the upper Tigris and Euphrates. Upstream damming reduced or eliminated seasonal flood pulses and made possible a concerted drainage effort in southern Iraq leading to drastic changes between 1991 and 1995. As a result of the drainage

Adams has long noted the role of marshlands as a place of flight from predatory rulership, and never discounted their supplemental subsistence importance (Adams 1981, 2002). However, for the southern alluvium during the crucial fifth and fourth millennia, wetlands must be at center stage of any nuanced discussion of adaptability and constraint. If adaptive flexibility explains the long history of cycling between urban agglomeration and ruralization in the southern alluvium, the “third leg” of littoral resources must be carefully more considered. Proxies for specific “processes” of social organization and control are open to reinterpretation.

As we have seen, Early Dynastic foundations were, from a geographic perspective, well-laid during the ‘Ubaid 4. The institutional foundations for subsequent management, replication, and intensification of marshland production (as distinct from marsh products and canal technologies per se) were laid during the Uruk. Both were predicated and dependant upon littoral communications with their hinterlands. Agricultural colonization of the southern Mesopotamian alluvium was made enduringly possible through exploitation by specialized communities of marsh fowl, fish, bitumen, shell, and reeds; by grazing herds on and cutting fodder from salt

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program, the Central and al-Hammar marshes have been eliminated save for water and reeds left standing in drainage canals. Al-Hawizeh, on the Iranian border, has been reduced by two-thirds, leaving just over 1,000 km^2 of intact, permanent wetlands. An additional 11,000 km^2 of *seasonal* wetlands are no longer subject to periodic inundation as a result of the combination of upstream damming and the explicit re-engineering of downstream flows (Partow 2001, Brasington 2003). Demographic impacts were considerable. As a direct result of the drainage program, the UNHCR estimates that at least 40,000 marsh dwellers sought refuge in Khuzestan, with another 200,000 internally displaced, for the most part to the outskirts of major cities (Iraq 1956; Koucher 1999; Partow 2001, Brasington 2003).

pastures; and by exchanging boat cargoes with near-neighbors. Sixth and fifth millennium settlements initially took localized advantage of productive littoral ecotones. By practicing local, small-scale damming and diking to build up permanently habitable platforms and to control the rate and progression of flooding and runoff, they accumulated “hydrologic capital” that gave them possession of the most suitable landscapes, led to the invention of technologies for flood and irrigation control, and developed institutions for labor mobilization.

During early urbanization and state formation, these wetlands—now almost fully destroyed and therefore difficult to imagine in their former extent—would have acted as an almost inexhaustible agro-pastoral buffer. Complementarity of resources would of course have provided local resiliency; but just as important would have been the replicability of these small, bounded, managed ecosystems at each sinuous loop; on each turtleback, and at each levee junction, where locally shifting plans brought minimal acreage into well-drained cultivation. Specializations and complementarities could thus have been placed beyond the reach of any locally destructive flood or drought. Communities sustained by marshland biomass and fed by the combination of farming-fishing-husbandry could produce sufficiently consistent agricultural surpluses and sufficiently robust trade networks to tilt the balance toward consolidation of local management structures. This preceded the work of straightening and regularizing channels and building new canals that came to characterize and fuel urban growth during the third millennium.

Insightful Mesopotamianists have already speculated about the contribution of wetlands and water transport to pre-urban southern Mesopotamian material culture.[101] However, only over the past decade has sufficient data accumulated to support the proposition that alluvial Mesopotamian cities grew from ‘Ubaid precursors heavily participant in and reliant upon littoral subsistence and exchange. Probably therefore, Mesopotamianists have not collectively considered the implications of those data. Algaze's import substitution model, discussed in Chapter One (page 17) must in this context be understood as a first outworking of the regional economic ramifications of this fundamental reassessment: a twofold “southern advantage” that may have overwhelmed the stability of supra-regional uniformity (or even advantages) in other social institutions.

The first is the inexorable advantage of the riparian environment: that it is simply easier to move bulky cargoes downstream than up, opening the possibility of (from the southern Mesopotamian perspective) downstream imports of bulk commodities in exchange for upstream exports of manufactured goods. The second is the inexorable advantage of the marsh, which exponentially compounds the transportation advantage by opening pathways across the southern alluvium. To be sure, Uruk’s (and its sister cities’) location would have conferred significant transportational advantage. This advantage would have been further compounded by the great reliability of wetlands renewed by annual floods in their fertility, by which is meant the greater biomass productivity of renewable, easily manipulated construction

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[101] Notably Woolley (1929, 1955, 1956); J. Oates (1960, 1969); D. Potts (1997); and S. Pollock (1999).

materials (reed, riparian woods),[102] easily gathered or readily hunted protein foodstuffs (fish, shellfish, fowl, pig), easily gathered carbohydrate foodstuffs (roots, tubers), and—significantly—reliable fodder (reeds, sedges). More importantly, in littoral ecotones, intensification of natural resource collection, hydrologic management, and cultivation are the primary mechanisms for *both* generating agronomic surplus *and* buffering against its failure.

The greater southern resiliency here described is not, therefore, a result merely of more varied resources (Wilkinson 2001), but, put simply, more resources—and, to return to my comments in Chapter One (see page 17), it is in this sense that Algaze's reference to "greater fertility" should be understood. Syro-Anatolia may or may not have been positively affected by generally wetter mid-Holocene climate (Weiss and Bradley 2001; Cullen et al 2000; Bar-Matthews, Ayalon, and Kaufman 1997; Lemcke and Sturm 1997) or a summer monsoon effect deduced from paleobotanical data for the Arabian Peninsula and (by extension) southern Iraq (el-Moslimany 1994). But it was precisely at the time of increased local precipitation variability, and during the general drying of the later fourth millennium BCE, that the alluvial "Mesopotamian advantage" of higher resilience became crucial. Here the marsh littoral provided both a sustainable resource base and a model for hydrologic management, sustaining experiments in intensification that may well have sought to recreate and preserve

[102] *Phragmites* and *Arundo* are so invasive and resistant to extermination by chopping or uprooting that one must posit them as invasive commensals, adapted to millennia of ethnographically attested overcutting for construction, matting, fodder and flour manufactured from their tubers (Salim 1962, Thesiger 1964, Ochsenschlager 1993).

previous natural conditions.

These compounded geographic advantages fueled Algaze's "synergistic cauldron" and favored accelerated urbanizing processes. In the rain-fed north, under climatic stress *ex*tensive ruralization—not *in*tensive urbanization—optimally supports both higher overall population and agrarian surplus production (Wilkinson 1994, Algaze et al 2001). This could help account for the undifferentiated sprawl of large, precocious settlements noted by Oates surrounding Brak. There, dry land was not a scarce commodity, and under optimal conditions rural settlements could have proliferated even as urban centers expanded. However, during periods of poor harvest, Syro-Anatolian polities would have been more constrained in their ability to overcome local or regional crop failures, since accessibility to the products of arable land would have been limited to the mobility of foot and hoof.

In the marshy alluvium, the situation of 'Ubaid towns, villages, temples, and associated temple economies on levees, turtlebacks, and marsh rims within the vast littoral created a kind of geographic circumscription-within-plenty. The high, dry ground itself, as well as associated permanent structures (temples, docks, ferries, kilns, dwellings), could have become contested, but the resource base supporting them remained readily accessible. In keeping with Oates' perceptive and foresightful 1960 conclusion, Ur's "flourishing in the same geographical position for some 5,000 years" (Oates 2001) is attributable to its situation in marshlands, its status therein repeatedly rejuvenated by the re-digging of canals.

I do not imply by this a crude environmental determinism. As Gil Stein eloquently summarizes:

> Culturally specific factors allowed for and encouraged the production and centralization of surplus crops, pastoral products, and aquatic resources from the south Mesopotamian ecological system. The ideological and economic role of temples in Mesopotamian culture is particularly important in this regard. Temples provided a ritually-based ideological focus that could mobilize labor and tribute from a social sphere far wider than that of a small set of resident patrilineages… Neither factor—environmental potential nor the temple-based ritual system—would have been sufficient *in and of itself* to explain the development of Mesopotamian urbanism. We can see this clearly by comparing the impact of temples in northern and southern Mesopotamia in the fifth millennium BCE, immediately before the development of the Uruk states. In the later fifth millennium, small-scale ‘Ubaid chiefdoms spread from the south to the north, bringing a temple-based form of ritual organization into the dry farming zone (e.g., at Tepe Gawra). However, in the centuries that followed, these Northern ‘Ubaid polities did *not* increase in scale, complexity, and integration. This stands in marked contrast to the rapid development of the *southern* ‘Ubaid temple-towns into large-scale urban settlements in the early fourth millennium. This is because the northern ‘Ubaid temples had the organizational technology to extract large-scale surpluses, but lacked the necessary resource base. Temples were thus a historically (or culturally) contingent factor critical factor in the development of Mesopotamian urbanism, but *only* when planted in the rich and diverse alluvium of the south. (Stein, personal communication to Algaze 2001, emphasis added.)

I stress here the first of these factors: *rich*. While Chip Stanish, following Murra’s (1980) ethnographic focus on vertically stratified ecosystemic complementarity in the Andes emphasizes the latter—“a mosaic of ecological niches” (Stanish 2001)—without diminishing the importance of cultivation and ovicaprids pastoralism, I must reemphasize in this case the comparative primacy of the former.[103] This point is particularly relevant in response to the questions:

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[103] Moseley (1975) argues the primary role of complementarity among maritime, irrigated coastal, cloud forest, and cordilleran resources in Andean state formation.

> Why would not random dramatic change…from the environmental advantages enjoyed in the fourth m BCE at least sometimes and in some areas have resulted in social homogenization and a heightened emphasis on subsistence production? Additionally, where adjacent areas with comparable resources show very different developmental trajectories, might not greater emphasis on historical contingencies explain inter-regional variation? (McCorriston 2001)

In the “balance” between “geographic predictability and dramatic climate and environmental change,” the disadvantages of both the general fourth millennium trend toward a (modern) regime of decreased and seasonalized annual precipitation and unpredictable (and to date not specifically characterizeable) inter-annual variation would have fallen disproportionately on the Syro-Anatolian plains. Within the delta, it the biggest, earliest, and most differentiated cities are also the “wettest” cities, linked (as McCorriston notes) by a “wet” trade in water-dependent plants, dyes, and products. While subject to unpredictable, destructive floods, they were (within limits) nonetheless, in the context of then-littoral landscapes, the better buffered from precipitation vagaries. They were, in short, given high inter-annual climatic variation, *less* risky places than the rain-dependent north—and sudden climatic variations would only have contributed over the short term to population infalls *toward* the marsh zones, allowing a deepening and institutionalization of Mesopotamian trade in, e.g., dyes and dyed stuffs.[104] Fish, shellfish, turtle, waterfowl, and pigs; reeds, sedges,

[104] Interannual variability assessment of rainfall, water flow, and flooding is essential to understanding cultivation, storage, and transport decision-making and strategies. Downstream water flow and flood levels for the mid-fourth millennium BCE (c. 3700–3350) may at this point be roughly inferred from unpublished dendrochronological data recovered near Anatolian Euphrates/Tigris headwaters, such as the five-species sequence from Arslantepe, near Malatya (P. Kuniholm, personal communication). However, direct evidence with annual resolution for monsoonal effects on fifth–fourth

tubers, and seasonal grasses sustained human and animal populations and provided massive quantities of handicraft and construction material. Littoral ecotones constrained habitation; annual floods replenished marshes and recessional gardens; the watery environment provided lines of communication that ensured rapid transmission of technologies, trade goods, and peoples themselves—even as these factors concentrated resources, produce, institutions, and know-how into the hands of the few, setting the stage for hierarchy and heterarchy.

A crucial aspect of the associated ideational flourit was the way in which it mediated and institutionalized built structures related to use of wetlands and, especially, the transitional zones on and along crucial, contested high ground. Rene Dittman argues that "the contents of the iconography of the Uruk period became an essential part of the Greater Mesopotamian symbolic context," (2001: 218) and a significant proportion of that content characterizes the wealth and diversity of marsh resources. There is here a corollary to Petr Charvát's invocation of the Mongongo nut mantra to argue that "a promising environment will hardly fulfill its potential if the humans living in it simply do not perceive its promise or prefer their traditional way of life…" (2001: 216), despite the fact that the situation of early fourth-millennium BCE estuarine farmers could not be less comparable to marginalized San foragers. What, indeed, "would have induced the southerners to apply so much energy to embarking

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millennium BCE rainfall in the southern alluvium is unlikely. A dendrochronology could perhaps be derived from dune burials of *Haloxylon.* Adams' use of modern records as an inter-annual proxy (Adams 1981)can only pertain to water flow and flood variations, as there is no modern monsoonal effect.

on a journey that is well known to us but absolutely original, new, and therefore potentially dangerous for them?" (Charvát 2001: 216) The answer may well be that, in the environmental sense, the journey was not so new, and not so original—giving wider play to social experiments that were indeed potentially dangerous, but more so for some than for others.

Sumerian administrators seem to have understood that productive wetlands were not just those areas delimited by permanent reed swamp, but included all that surrunding area, seasonally dry, "created" by farming and grazing, that revert to dust, mud, or water during a year's progress. While colonial administrators at the turn of the century could not help but see annual floods as destructive; as wasteful; as a time when nothing was planted, and nothing harvested, five thousand years ago, the floods began a kind of processional year. Boat travel became possible across wide reaches. Trading, raiding, and ritual cycles commenced. An assertion of land as political will; land as political instrument; a move from exploiting terrain as an assertion of political will, to creating landscape as an attestation of political will, became possible once again. The Boundary Commission surveyors *en procession*; the infantryman slogging through Mesopotamian bogs, resorting to a flotilla of boats and rafts enroute Nasiriya; the man in a net skirt, with his cow, his temple, his storehouse doors, and his spear-fisher, poled through the marshlands in an identical craft; are all kinds of ritual procession: at once politics and warfare, that unleash chaos, so that in its resolution anarchy does and must coalesce along political lines.

Such rituals provoke resistance and test loyalty; create memory and memorial;

they require and display humiliation and subjugation for some; hope and acquisition for others. Most of all, they create, legitimate, and enforce social contracts regarding the use of space and resources. They are the means by which terrain becomes landscape. There, in the delta, as the rivers move, new lands (and opportunities) are ever re-created, and the ritual ever reinacted.

The gradualist innovative efficiency of Uruk elites was more encompassing than irrigated cultivation, agricultural accountancy, or industrial production. Important though these innovations may have been, they are both precursors and products of a broader conceptual transformation that, in the act of recognizing complementary obligations, enforced an enduring dichotomy between an urban core and a subjugated outland. The basis of the transformation of terrain outside cities from socially unranked, undifferentiated wetlands, into alienated, ranked, extra-urban hinterlands was not the totalizing economic vision of an extra-regional colonial administrator. This was no imperial imperative that sought to reshape entire regions to specified productive ends. Rather, the transformation was undergirded by a cosmology expressed as a landscape vision that promised divine beneficence, while recognizing the place of wetland residents' material contributions to the totality of an idealized good.

Table 17: Air observations over Suwaiqiya and Gussab marshes, May–December 1916

Date	Marsh	Mat Shelters	Stacks Boosa	Sheep (Cattle)	Grain	Pilot/Observer	Comments
1915–6	Suwaiqiya						Flooded in January, permanent but very brackish in autumn, where dry crusted with salt 1–2' deep.
25 May	Gussab	400	Yes			Murray/Ortner	Shelters in groups of 20, 50, 60, 60, 70, 100.
25 May	Shatt al Hai	100		Huge flocks		Murray/Ortner	In flood. Shelters in groups of 40, 60.
5 Jun	Baghi Shahi			Large flock	Harvest	Rodney/Gluver	Cultivated area where grain is collected. Where old tracks strike edge of marsh where water is lying, bundles of grain along edge of marsh for three miles.
5 Jun	Mandali	150				Rodney/Gluver	
13 Jun	Baghaila						
4 Jul	Tursakh	200	Yes			Rodney/Ortner	Matting huts appear to be 15 yards long by 5 yards broad. Contain two doorways and have a pointed roof probably of reeds. Neat stacks of grass parallel to huts.
4 Jul	Kut					McCorindle/Bagnall	Much water SW of Suwaiqiya, S of Kut, and in Hor Gussab.
4 Jul	Kut					McCorindle/Bagnall	Much water SW of Suwaiqiya, S of Kut, and in Hor Gussab.
4 Jul	Kut					McCorindle/Bagnall	Lake to NW drying around edges
4 Jul	Suwaiqiya, ibn Jizan					McCorindle/Bagnall	1000 yards over bunds.
4 Jul						McCorindle/Bagnall	Ship canal: shallow water in strips from Hai; Nahr ibn Jizan: Dry. Mud bottom;; Hai Canal: deep enough for Mahaila traffic;Shatt al Hai: Nullahs S of ibn Jizan are dry for 12 mi.
4 Jul	ibn Jizan:					McCorindle/Bagnall	Green reedy marsh
4 Jul	Tel Thiak					McCorindle/Bagnall	series of small ponds connected by reeds
4 Jul	Basrahqiya, Baghaila					McCorindle/Bagnall	Lakes drying
4 Jul	Abadiyah					McCorindle/Bagnall	flood to N now pond 1 mile diameter—remainder marsh
4 Jul	Gussab			Few, (200)		McCorindle/Bagnall	Arabs collecting grass at reed edge. Cattle N of pond.
21 Jul	Gussab			1000		Rodney/Mitchell	Deshaila breeches flooded, flood S of Kut 1 km2, flood end of Basrahqiya ½ km2, Gussab flooded and edged with reeds.
22 Jul	Gussab		Yes	5800–6800		Rodney/Thompson	4–5000 NW of fort and 1800 along dry canal
23 Jul	Gussab			400 (200)		Swanson/Sanctuary	In dry bed

Date	Marsh	Mat Shelters	Stacks Boosa	Sheep (Cattle)	Grain	Pilot/Observer	Comments
23 Jul	Baghaila				plowing	Swanson/Sanctuary	Agriculturalized areas along banks of drying bunds
23 Jul	Shatt al Hai			150 buffalo (200)		Swanson/Sanctuary	
25 Jul	Gussab			5800–6800		Swanson/Sanctuary	4–5000 NE of fort and 1800 along dry canal
26 Jul	Gussab	95	40	5800–6800	Harvest		Men working among boosa stacks, half carted away; boosa harvest, grain harvest, stibble grazing
26 Jul	Baghaila	560					Groups of 30, 40, 50, 100, 50, 100, 100, 50, 40. Agriculture where drying; ponds forming along N bund.
28 Jul	Shatt al Hai			300–400	Threshing		E Bank 22 stacks grain; pack ponies carrying grain to threshing areas. Grazing to W. Shatt shallow.
29 Jul	Shatt al Hai	many		many	Stacks	Horstius/Sanctuary	
29 Jul	Gussab	Ring lake		3000 (200)		Horstius/Sanctuary	Flocks of 1500, 1000, 500
30 Jul	Shatt al Hai			3000			Crossing west-to-east over ford to Gussab
31 Jul	Shatt al Hai			1000			Crossing west-to-east over ford to Gussab
1 Aug	Shatt al Hai	240	30			Chabot/Barr	E. side of Basrahqiya marsh and near Zarabiya
2 Aug	Shatt al Hai	Dug-in				Chabot/Cochran	20’ long and covered w/ matting
2 Aug	Suwaiqiya					Chabot/Cochran	Running N–S, 5 mi wide in center and 3 mi at edge
3 Aug	Gussab		Yes	1000		Windsor/Browning	Large boosa supply, vic. of reeds dotted with stacks
3 Aug	Suwaiqiya					Browning/Mitchell	Sheep tracks running down to water in N.
	Shatt al Hai		Much				Vic ford. Vegetables are being grown along river bed as it dries.
4 Aug	Tigris	60		1000		Hayword/Orton	West of Kut at Shumrain and Dahran breeches
	Shatt al Hai		Much				S. of Zenubiya; canal shallow. Baghla breech dry for 5 miles.
5 Aug	Shatt al Hai	0					New shelters gone.
6 Aug	Shatt al Hai					Windsor/Creswell	Crossing Basrahqiya ford W–E.
6 Aug	Gussab		20	1800		Windsor/Creswell	Shatt almost closed. Lakes drying. Sheep still in damp canal bed.
9 Aug	Shatt al Hai		50	(Penned)		Chabot/Bagnall	Large solid mud flat on which are a number of cattle pens, divided from one another by a brush-wood hedge. Started on other flats as they become dry.
8 Aug	Bani Rabiya	390			Yes		Shelters in nine camps
9 Aug	Badra			4000		Haviland/Browning	4.5 miles downstream., in several flocks. Foothills watercourses dry.
11 Aug	Suwaiqiya					Lander/Forsyth	Edges drying quickly
11 Aug	Gussab	same	80	2000		Lander/Forsyth	Considerable amount of boosa lying about; reed lake
12 Aug	Gussab		80+80			Gresswell	

Date	Marsh	Mat Shelters	Stacks Boosa	Sheep (Cattle)	Grain	Pilot/Observer	Comments
13 Aug	Shatt al Hai					Bagnall	Channel width 3’, ¼–1/2 bed, no place is dry bank to bank
14 Aug	Sanniya			(12,000)		Rodney	Vic. Ali Ash Sharki
17 Aug	Gussab					Windsor/Bagnall	Water rapidly drying; now two small lakes (remainder marsh)
18 Aug	Gussab			5,000			Continues drying through 25 August
17 Sep	Suwaiqiya						Edges slightly receding
17 Sep	Gussab	remain		gone			
26 Sep	Gussab						same
1 Oct	Jassan	200	much	(100)		Chabot/Bluso	Stacks of boosa at each shelter
1 Oct	Suwaiqiya					Hopkins/Hudson	Slightly brackish but drinkable. Depth at center unknown but edges shallow. Bottom is generally firm and walking comparatively easy. Shoreline withdrawn by 2 km. average. Innundation from Tigris breeches at Kut now dry except for scattered lakes 6 km X 1 km.
1 Oct	Gussab			3,000		Hopkins/Hudson	Sheep remain near fort.
1 Oct	Shatt al Hai			(200)		Hopkins/Hudson	
3 Oct	Suwaiqiya			2,000			Moving NE from SW corner
5 Oct	Jassan	600	Yes	4,000	Yes	Chabot/Bluso	
5 Oct	Badra	190		4,000		Chabot/Bluso	
5 Oct	Tursakh	375				Chabot/Bluso	
5 Oct	Bani Rabia			4,000			
5 Oct	Badra			3,000 (400)			
5 Oct	Gussab			1,000 (500)			At fort
9 Oct	Jassan						No changes
9 Oct	Badrah	150		7,000			Sheep feeding along foothills
9 Oct	Madali	100					23 rows of long mat shelters 40’ long in rows of 2–7’
9 Oct	Bani Rabiya	500	much				At marsh rim
12 Oct	Gussab			dispersed			To north in flat, open plain
17 Oct	Suwaiqiya			2–3,000			Sheep moved to north of Tigris
19 Oct	Shatt al Hai			(4,000)			In bed below Gussab ford
20 Oct	Shatt al Hai			2,000			At Gussab ford
21 Oct	Shatt al Hai			200 cattle			Watering at ford
27 Oct	Gussab			10,000 cattle			
27 Oct	Shatt al Hai			2,000			At Atab

Date	Marsh	Mat Shelters	Stacks Boosa	Sheep (Cattle)	Grain	Pilot/Observer	Comments
28 Oct	Shatt al Hai			3,000			At Atab
2 Nov	Gussab			1,000			To north
2 Nov	Shatt al Hai			2,000			Watering
6 Nov	Shatt al Hai				cultivation		
8 Nov	Shatt al Hai			4,000			Grazing at Atab
11 Nov	Shatt al Hai			800			At Atab
13 Nov	Jassan			3,000			
14 Nov	Kut			(5,500)			In bed of Tigris
15 Nov	Shatt al Hai			5,000			Water flowing to Atab, sheep to south
25 Nov	Baghi Shahi						Abt-i-shargula brackish but drinkable
26 Nov	Suwaiqiya						Lake down about 2 k m from margins.
1 Dec	Shatt al Hai			1,000			No water flowing. Sheep at ford N. of Atab.
2 Dec	Gussab			1,000			
8 Dec	Shatt al Hai						Fordable every few hundred yards. Ground swampy. Bed used for watering livestock and as roadway.

Sources: PRO KEW MR 1/1028 [Maps, formerly AIR 1/440}, 30 Squadron Aerial Reconnaissance reports. MFQ 363, Parts I/2, 4, 7, 9, 11; II/24, 27, 34, 39, 49, 67, 85 III/98, 117, 123, 130, 133, 149, 159, 160; IV/188, 193, 200,209, 223, 270, 235, 238, 241; V "Aeroplane reports for December 1916 I Branch 1st Indian Army Corps/251, 254, 259, 261, 267; VI Jessan Bedrah. MFQ 364 Parts I/8, 14–16, 39; II/57, 60, 63, 69, 71, 75, 80, 83, 85, 86, 90, 94; III "Aeroplane Report Book August 1916"/98, 106, 109, 111, 116, 120, 121, 122, 125, 127, 131, 140, 149, 155, 159, 161, 170; IV/178, 192; V; VII; VIII;X/447

*Reference: Map, series: Persia and Turkey in Asia 1914/1915, sheets: TC 2G, 2H, 2K, 2L, scale: 1"=1/4 mile or 1:253,440. Published by Survey of India , directed by Col. Sir S.G. Burrard.; Pusht-i-Kuh 1916, sheets TC 41, 63, 64, scale: 1"=2 miles .

Table 18: 20th-Century Geographies, Ethnographies, and Travelogues treating the Wetlands of Southern Iraq. See Figure 87.

NO.	AUTHOR	DATE	MARSH REGION	DETAILED ENVIRONS	MAJOR CRPOS, PRODUCTS
1–10	UK NID	1944	All	Basra, Maqil	Nomads, fish, dates, barley, wheat, rice
2B–10	Wirth	1962	Euphrates	Diwaniya, Rumaitha	Palm gardens, rice
			Tigris	Amara	Rice, winter wheat
			Gharraf	Hai	Barley
			al-Arab	Zubair	Dates, vegetables
	Al Barazi	1961	Mid-Euphrates	Karbala–Diwaniyah	Grain
	Fernea	1965	Mid-Euphrates	Diwaniya (el-Nahra)	Rice
2AB	RAF	1916	N Tigris–Gharraf	Kut	Reed; winter pasture See Table 17, Figure 86.
3	Ochsenschlager	1993	Lower Gharraf	Shatra (al-Hiba)	Sheep, carpets, fish, barley
6	Hedgecock	1927	Upper East Tigris	Amara–Qalat Salih (Musaida),	Rice, water buffalo
6	Maxwell	1957	Upper East Tigris	Amara–Qalat Salih (Turaba)	Water buffalo. See Figure 67.
5–6, 7 4, 8 9	Thesiger	1964	Tigris–Euphrates delta, esp. W Tigris	Amara (Qabab)–Saigal–Nasiriya (Ech-Chubayish)–Qurna (Howair); smaller villages in deep marsh	Buffalo, cattle, sheep. reed, mats, rice, fish, fowl, pelts, pigs. See Figure 66.
5–7	Westphal-Hellbusch	1962	Tigris, esp. West	Amara–Saigal–	Cattle, reed, mats, buffalo, yarn, rice, fish, pelts
9			Lower T–Euphrates	Qurna (Birriz)	Palm gardens, reed, buffalo, rice
8–9	Salim	1962	Lower Euphrates	Ech-Chubayish	Reeds, mats, salt, fish, millet, cattle. See Figure 85.

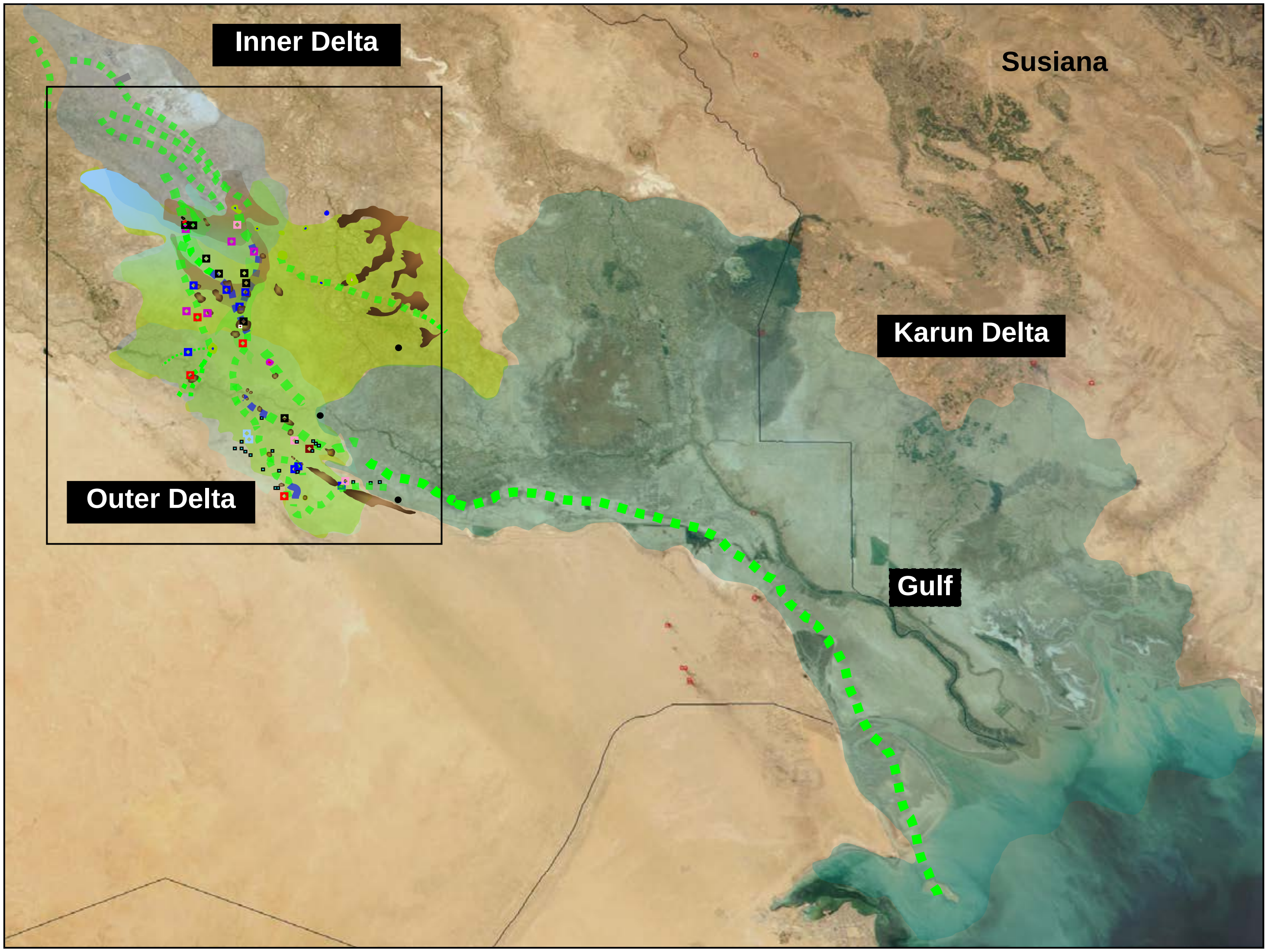

Figure 89: The Mesopotamian Delta, circa 4000 BCE. Maximum marine transgression coincides with the ‘Ubaid–Uruk transition. Imagery, geological, and archaeological evidence is consistent with the formation of a freshwater inner delta in the Nippur–Dalmaj region, transitioning to a fresh–brackish mixing zone and outer delta in the Warka, Eridu, and East Gharraf basins. Hypothetical waterways (dotted green) are based upon later levees, flood basin sediments, and site distribution. Boxed: Figure 89

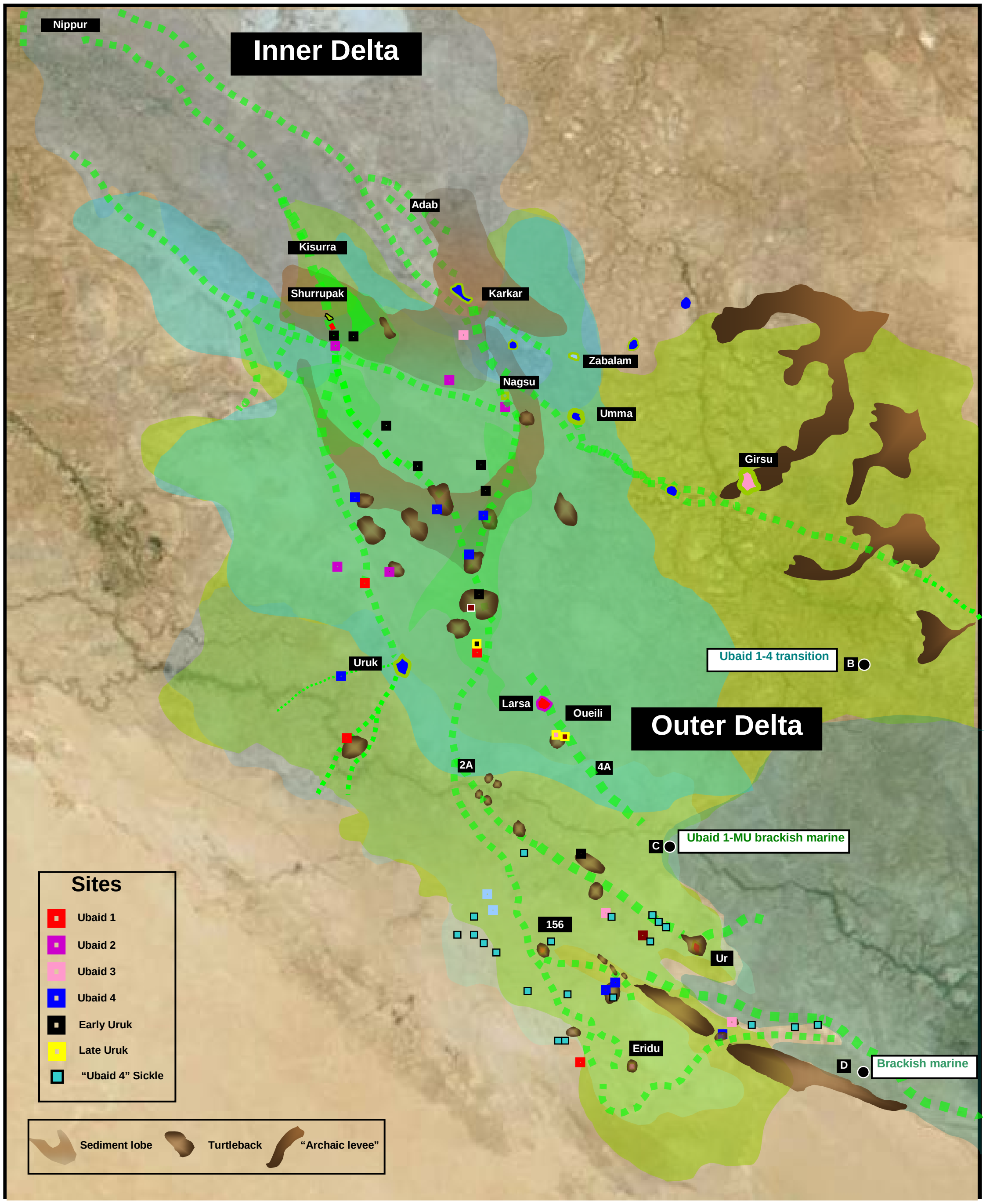

Figure 90: The Mesopotamian Outer Delta, circa 4000 BCE. Hypothetical waterways (dotted green) are based upon later levees, flood basin sediments, and site distribution.

MAP: THE MESOPOTAMIAN ALLUVIUM

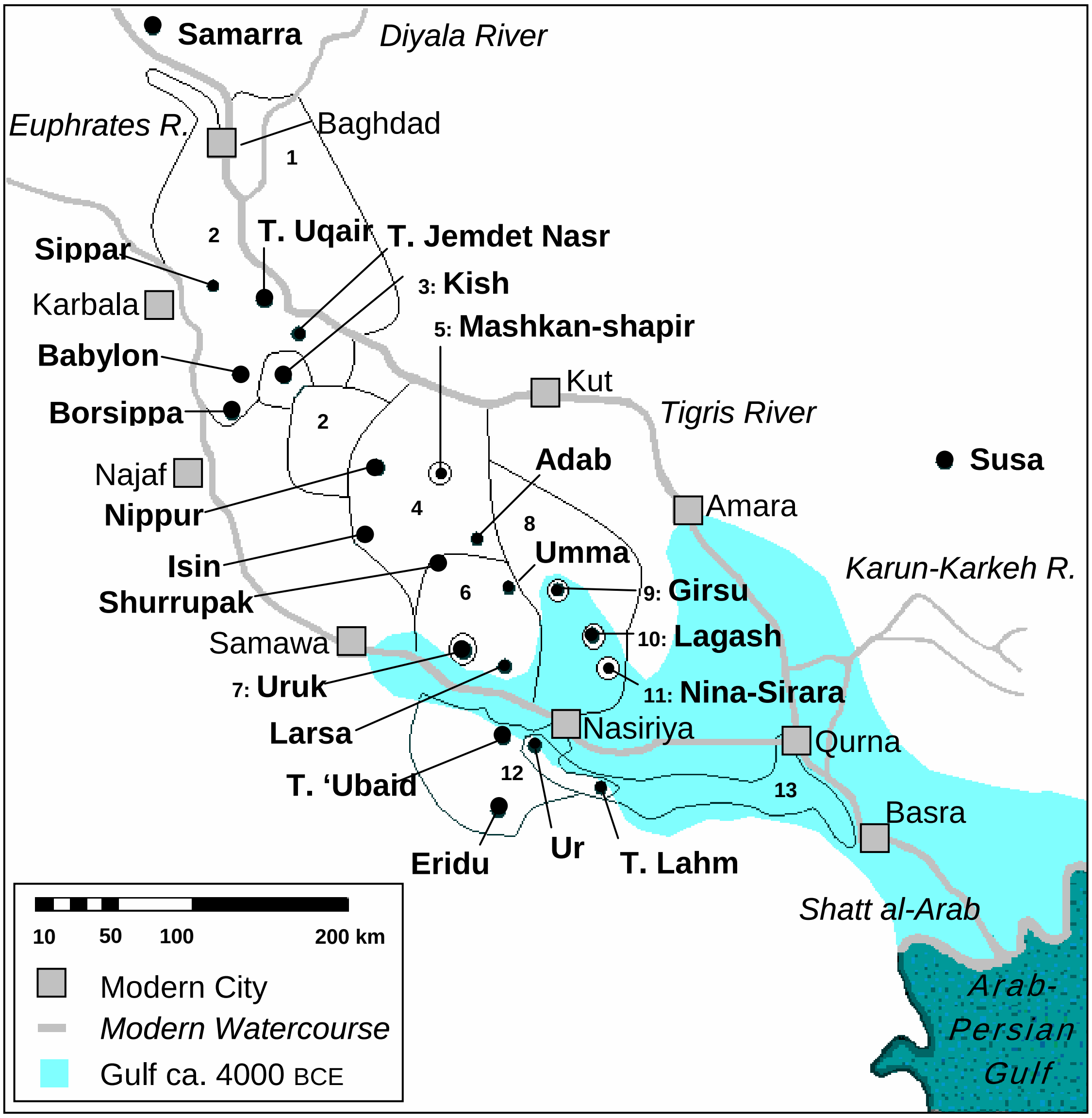

Figure 91: Major archaeological sites of alluvial Mesopotamia, with surveyed areas and hypothetical extent of the Persian Gulf ca. 4000 BCE. **1.** Diyala Survey. **2.** Akkad Survey. **3.** Kish Survey. **4.** Nippur Survey. **5.** Mashkan-Shapir. **6.** Warka (Uruk) Survey. **7.** Uruk. **8.** East Gharraf area, with: **9.** Tello Region, **10.** Lagash, **11.** Zurghal (Nina-Sirara). **12.** Ur-Eridu Survey. **13.** Hammar Lake Survey. See Table 7; Figure 15.

CHRONOLOGY OF PERIODS MENTIONED IN TEXT

PERIOD (=Egypt)	PROMINENT SITES/*ANCIENT NAME (LEVEL)*	BCE (CE)	NOTED PERSONAGES
LATE NEOLITHIC–EARLY CHALCOLITHIC			
Ubaid 0	Oueili (Awayli)	6500–5900	
Ubaid 1	Abu Shahrain/*Eridu*	5900–5200	
Ubaid 2	Haji Muhammad	5200–5100	
CHALCOLITHIC			
Ubaid 3	Tell Al-Ubaid	5100–4900	
Ubaid 4	Tell Al-Ubaid	4900–4350	
Terminal ‘Ubaid	Warka/*Uruk/Erech (Eanna XVI–XIV)*	4350–4200	
Early Uruk (Naqada I)	*Uruk (Eanna XIV–XIII)*	4200–3800	
Middle Uruk (Naqada II a–b)	Abu Salabikh; *Uruk (Eanna XII–VII)*	3800–3400	
(Protohistoric Periods)			
Late Uruk (Naqada II b–c)	*Uruk (Eanna VI–IVa);* Niffer/*Nippur (Inanna XVI–XV)*	3400–3200	Enmerkar
Jemdet Nasr (Naqada II d–IIIb1)	Jemdet Nasr*; Uruk (Eanna VI–I/7); Nippur (Inanna XIV–XII)*	3200–3000	
EARLY BRONZE (Historical Periods)			
Early Dynastic I (Naqada III)	*Uruk (Eanna I/6–I/1); Nippur (Inanna XI–IX a);* Sakheri Sughir	3000–2750	Gilgamesh, Enmebaragesi?
Early Dynastic II	Bismaya/*Adab; Khafaja;* T. Asmar	2750–2600	Ziusudra, Meselim; Lugalshagengur?
Early Dynastic III	Muquayyar/*Ur;* Fara/*Shurrupak; Adab;* Abu Salabikh, Tello/*Lagash, Nippur*	2600–2350	Pu-abi, Mesannepada; Ur-Nanshe, Eanatum, Enanatum I & II, Enmetena, Enentarzi, Lugalanda, Urukagina; Lugalzugezi
Akkadian	*Nippur*; Al Hiba/*Girsu;* T. Brak	2350–2150	Sargon, Rimush, Manishtushu, Naram-Sin, Sharkalisharri, Gudea
Ur III	*Nippur, Ur, Umma*	2150–2000	Ur-Nammu, Shulgi, Amar-Suen, Shu-Sin, Ibbi-Sin
*MIDDLE–LATE BRONZE			
Isin-Larsa	*Nippur, Ur, Isin,* Senkereh/*Larsa, Mashkan-shapir,* Babylon	2000–1763	Ishme-Dagan, Enlil-bani, Damiq-ilishu; Rim-Sin
Old Babylonian	*Sippar,* Babylon/*Babil, Mashkan-shapir*	1763–1600	Hammurapi
(*omitted: Old Assyrian, Cassite, Neo-Assyrian—Nebuchadnezzar I, Tiglathpileser I, Ashurnasirpal II, Shalmaneser III, Sargon II, Sennacherib, Esarhaddon, Ashurbanipal)			
CLASSICAL			
Neo-Babylonian		626–539	Nebuchadnezzer II, Nabonidus
Achaemenid–Hellenistic		539–331	Cyrus (Persia), Alexander, Seleucus (Greece)
Parthian		126–(227)	Artabanus II
Sassanian		(224–642)	
ISLAMIC			
Abbasid		(750–1258)	
Ottoman		(1516–1914)	
Modern		(1914–89)	

Sources: Bertman 2003: 341, Rothman 2001: 7, Wilkinson 2000a: 225, Kouchoukos 1998: 190–97, Zettler and Horne 1998: xiii, Postgate 1994: 39, Walters 1970: xviii

GLOSSARY

ANADROMOUS: ascending rivers from the sea for breeding, e.g. salmon, shad

ANTICLINE: An upward flexure of the Earth's crust, such as a mountain range formed where one tectonic plate slides over another.

ASTER: Advanced Spaceborne Thermal Emission and Reflection Radiometer, an imaging instrument mounted on Terra, a satellite launched in December 1999. As part of NASA's Earth Observing System (EOS), ASTER obtains detailed maps of land surface temperature, emissivity, reflectance and elevation as part of NASA's Earth Science Enterprise, which studies interactions between the biosphere, hydrosphere, lithosphere and atmosphere.

AWHAR: The freshwater wetland zone of southeastern Iraq, characterized by permanent fresh-to-brackish lakes, permanent reed marshes, and seasonally inundated tracts of mixed grasses, bulrushes, and sedges, distinct from the salt marshes of the outer delta.

BOG: A peat-accumulating wetland with little in- or out-flow that supports acid-loving mosses such as *Sphagnum.*

BOOSA/QUSAH/GUSAB: fodder, especially reeds, sedges, and grasses cut seasonally in wetland margins.

BULRUSH: an edible sedge, requiring continuously wet shallow standing water, of the genera *Scirpus*, commonly used for fodder and in basketry and twine-making.

CATADROMOUS: descending rivers to the sea for breeding, e.g. eel, mullet

COASTAL: pertaining to land near the shore of an ocean, or inland sea, e.g. Mediterranean, Red Sea, Persian Gulf

CORONA: the program name for the first operational space photo reconnaissance satellite. Colloquially, the photographs produced by several sattelites and camera systems operated under that program.that program 1958–72.

DELTAIC: pertaining to the alluvial deposit at the mouth of a river, generally encompassing lacustrine/lakeshore; riverine/riparian, lagoon/marsh, estuarine/swamp, and maritime/coastal pelagic/littoral/ zones.

DOLOMITE: a mineral consisting of a calcium-magnesium carbonate $(CaMg(CO_3)_2$ found in crystals and in extensive beds as a compact limestone.

ECOTONE: the transition area between two ecological communities.

ESTUARY/ESTUARINE: pertaining to a water passage where the tide meets a river current, especially an arm of the sea at the lower end of a river, e.g. Basra inlet.

FEN: A peat-accumulating wetland with sufficient drainage from surrounding mineral soils to support marsh vegetation.

FORAMINIFER: an order of marine protozoa and component of plankton or benthos. On death, through compaction calcareous shells form the bulk of chalk and some limestones.

GASTROPOD: a large class of mollusks, usually with a univalve shell, such as limpets, cones, and conches. Those without shells are not preserved in the archaeological record.

GRAMINAE MARSH: See reed swamp.

HAUR: a seasonal lake or permanent fresh or brackish marsh of the Mesopotamian delta, to include the surrounding seasonal grasslands and central playa remaining after water evaporation. *Haur* boundaries vary seasonally and interannually with water recharge rates. See also *hor*.

HOR (KHOR): a permanent lake or open tract of fresh-to-brackish water within a reed swamp of the Mesopotamian delta; the most deeply inundated portion of a *haur*.

LACUSTRINE: of, relating to, formed in, living in, or growing in (freshwater) lakes.

LAGOONAL: pertaining to a shallow sound, channel, or pond near or communicating with a larger body of (especially salt) water.

LAKE (L.): as labeled in figures, a *hor* or *haur*.

LAMELLIBRANCHIA: an order of bilaterally symmetrical hinged bivalve mollusk, such as clams, oysters, and mussels.

LANDSAT: A family of satellites, first orbited 26 July, 1972, carrying multispectral scanners that digitally record discrete bands of visible and invisible light reflected from the earth’s surface. Colloquially, the images produced from those digital recordings using computer processing. During image processing, individual wavelengths are manipulated and assigned to visible colors in order to produce “false color” enhancements of vegetation, land use, geology, hydrology, and other environmental characteristics. Processed images may then be printed photographically, but such prints reflect only a subset of data produced for a particular purpose, not a conventional photographic recording.

LITTORAL: specifically, pertaining to a coastal shore zone lying between high and low tide marks. More generally, pertaining to aquarian ecotones, e.g. the border between land/water, freshwater/saltwater, grassland/marsh.

MANGROVE, MANGROVE SWAMP: coastal wetland dominated by trees and shrubs growing in brackish-to-saline tidal waters. Also, a common name for the many species of trees and shrubs therein.

MARINE: of or relating to the sea.

MARITIME: of, relating to, or bordering on the sea.

MARSH: (American usage) a frequently or continually inundated tract of soft, wet land usually characterized by monocotyledons such as reeds, grasses, sedges, and cattails. (European usage) As above, but specifically with a mineral soil base that does not accumulate peat. See also Reed Swamp.

MODIS: Moderate Resolution Imaging Spectroradiometer. A multispectral imaging sensor aboard NASA’s Terra Earth Observation satellite.

MONOCLINE: A level trend in the Earth’s crust.

OSTRACOD: an order of crustaceans with body parts enclosed in a hinged bivalve carapace. Because the legs are hidden they may at first be confused with small bivalve mollusks. Ostracods are often overlooked because they are so small but can be very common, and geologists rely on the fossilized carapaces of ostracods to date sediments. Also known as seed shrimp.

PALYGORSKITE: a white or gray pale lavender mineral, often classified as a clay mineral because it is present in some soils, consisting of hydrated magnesium aluminum silicate hydroxide $(Mg, Al)_2Si_4O_{10}(OH)\text{-}4H_2O)$. Found in hydrothermal deposits, soils, and along faults often lining the slicken sides of fault lines, it also forms matted felted masses that closely resemble woven cloth. Also known as attapulgite or, in its felted form, "Mountain Leather," it appears with attached calcite crystals that look like interwoven glass beads.

PELAGIC: of, relating to, or living or occurring in the open sea

POCOSIN: Peat-accumulating, non-riparian freshwater wetland, generally dominated by evergreen shrubs and trees and found on the southeastern coastal plain of the United States. From the Algonquin for “swamp on a hill.” (Mitch and Goss link 2000: 41).

PHYTOLITHS: minute silicate particles formed within living plant cells, in shapes and structures characteristic of genera and species. More durable than pollen grains, phytoliths are often the only paleobotanical evidence remaining in slty, gypsiferous Mesopotamian soils.

REED SWAMP, SWAMP: (U.K. usage) A *Phragmites*-dominated marsh.

REED: an herbaceous grass standing up to six meters in height, requiring continuously wet shallow standing water, commonly used for fodder, construction, boat-building, thatching, and woven mat-making. *Phragmites* australis (communis), also known as reed grass, is the dominant species carpeting fresh water marshes of southern Iraq.

REEDMACE, REEDMACE SWAMP: (U.K. usage) Cattail, cattail marsh.

RIPARIAN: pertaining to the bank of a natural watercourse (as a river), surrounding land characterized by a high water table, and associated water-seeking woody vegetation such as palm, willow, and poplar. Also called bottomland hardwood forest, floodplain forest, Bosque, riparian buffer, and streamside vegetation strip.

RIVERINE: of, relating to, formed in, living in, or growing in rivers

SABKHA: An environment of coastal sedimentation characterized by arid or semiarid conditions above the level of high tide and by the absence of vegetation. Evaporites, aeolian deposits and tidal-flood deposits are common in sabkha, especially the thick gypsum crust left after the evaporation of standing water from shallow basins.

SALT GRASS: *Spartina* patens, a halophytic grass, requiring continuously waterlogged soil and tolerant of shallow standing salt water, commonly used for grazing, fodder and in twine-making. Also known as cord grass.

SALT MARSH: a halophytic vascular plant community on alluvial sediments bordering saline water bodies with fluctuating water levels.

SEDGE: A thick-rooted grass-like hydrophytic monocotyledon with triangular stem cross-section, notably, *Carex* sp.

SWAMP: (U.S. usage) a wetland often partially or intermittently inundated with water and dominated by hydrophytic woody vegetation such as cypress, mangrove, palm, willow. In U.K./Europe, known as Wooded Swamp. See also Reed Swamp.

SYNCLINE: A downward flexure of the Earth’s crust, as is formed where one tectonic plate slides beneath another.

TELL (T.): a mound (Arabic: *Tell*, Persian: *Tepe*, Turkish: *Höyük*) resulting from repeated occupation, leveling, and rebuilding with mud brick on the same locale. In the Mesopotamian delta, tells are generally the only feature of any significant elevation above plain level.

TERMINUS ANTI QUEM: date before which an event must have occurred. For example, a datable settlement situated on the crest of a meander scroll dates that scroll to some period prior to establishment of the settlement. Care must be taken, however, to determine that the *base* of the settlement in fact lies above the dated feature. It is possible for a high point of an earlier sediment to protrude through subsequent sediments, and this can be difficult to discern on imagery.

TERMINUS POST QUEM: date after which an event must have occurred. For example, datable archaeological materials sealed within a sediment dates material deposited above that sediment to some later period. However, care must be taken to determine that adjacent earlier material has not been folded over the later sediment—often a problem in deltaic contexts.

WETLANDS: various (often interconnected) ecotones distinguished by the permanent or seasonal presence of water either at ground surface or within the root zone, characterized by high bioproductivity, and often exhibiting unique soil conditions that support hydrophytes and discourage flood-intolerant species. These include (among others) seagrass beds, marine littorals, mangroves, salt marshes and brackish estuaries; freshwater wooded swamps, reed swamps (graminae marshes), riparian floodplains, lacustrine basins, fens, and bogs.

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