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Bricks and urbanism in the Indus Valley rise and decline

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Abstract. The Indus Valley Culture (IVC), often denoted by its major city Harappa, spanned almost two millennia from 3200 to 1300 BC. Its tradition reaches back to 7000 BC: a 4000 year long expansion of villages and towns, of trading activity, and of technological advancements culminates between 2600 and 1900 BC in the built-up of large brick-built cities, writing, and political authority; the IVC emerges as one of the first great civilizations in history. During the ensuing 600 years, however, key technologies fall out of use, urban centers are depopulated, and people leave the former core areas of the IVC; although many different hypotheses have been put forward, a conclusive causal chain for this decline has not yet been established. We here combine literature estimates on brick typology, and on urban area for individual cities; in the context of the existing extensive data on Harappan artifact find sites and put in their chronological order, the combined narratives told by bricks, cities, and extent, can provide a new point of departure for discussing the possible reasons for the mysterious decline.

1. Introduction

In the 1850s, ancient bricks stolen from ruins near Harappa, a town adjacent to the River Ravi in Punjab, Pakistan, attracted archaeological investigation. The bricks were first thought to be part of a Buddhist site, until Marshall (1924) attributed them to an indigenous civilization of South Asia, the Indus Valley Culture (IVC, 3200–1300 BC), whose brick architecture extends back to 7000 BC and the valleys of Baluchistan (Possehl, 1990; Jarrige et al., 1995; Kenoyer, 1998).

The building material for the villages and cities of the IVC was predominantly mud brick. Only in the Mature phase were baked bricks used in quantity, especially for walls and floors exposed to water (Possehl, 2002; Datta, 2001). This phase of baked bricks coincides with the the urban phase of the IVC, with many large cities as opposed to the predominant village settlements before and after the Mature phase. The urban phase also spans the period where all key technologies of the IVC, including writing, shell orna-

ments, weights, and seals are present; these fall out of use with deurbanization after 1900 BC (e.g., Kenoyer, 1998; Datta, 2001; Possehl, 2002; Law, 2007).

At the height of the Indus Civilization, there is an intimate relationship between key technologies, building material, and cities. Or, translated into the social realm, between social and political organization, craftsmanship, and life style. The investigation of the combined evidence for technologies, material, and cities could then possibly inform us about the social, political, or organizational factors involved in its decline. We reconstruct here the chronological dynamics of brick usage by typology, and of urban area for the entire IVC from individual estimates. Combined with existing extensive data on Harappan artifact find sites a narrative of the rural-urban relationship of Harappans emerges. This relationship can provide a new point of departure for discussing the possible reasons for the mysterious IVC decline.

2. Indus Valley chronology and extent

Several chronologies have been developed for the IVC, of which those by Kenoyer (1998) and by Possehl (2002) are widely employed. From these two,

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we differentiate an Early Neolithic period, consisting of the Kili Ghul Muhammad (7000–5000 BC) and Burj Basket-Marked (5000–4300 BC) phases, a pre-Harappan or Developed Neolithic period with the Togau (4300–3800 BC) and Hakra-Kechi (3800–3200 BC) phases, the IVC proper represented in the Early (3200–2600 BC), Mature (2600–1900 BC), and Late (1900–1300 BC) Harappan phases, and a post-Harappan phase (from 1300 BC).

As the constituent phases have been developed from local stratigraphies at type sites dispersed throughout the IVC domain, conflicting phase boundaries, multiple naming for cotemporal phases, and phase overlaps, a separation in the eight phases named above is overly simplified and in a way arbitrary; this simplification is necessary, however, to be able to address the global developments within the IVC in a common temporal frame (Fuller, 2006; Gangal et al., 2010; Lemmen and Khan, 2012). But even if when common temporal frame is established, the dates given in years BC should be treated with caution, as more often than not precise dating has not been performed for most sites. Here, we rely on previously published local chronologies (Tab. 1); as the focus of this paper is not on discussing the divergent local chronologies and dating problems, we continue our analysis in the awareness that this chronology is subject to discussion and further refinements in many places.

The Indus Valley cultural tradition dates back to 7000 BC and the foothills and valleys of Baluchistan. At the site of Mehrgarh, early food production was dated to 6500 BC (Jarrige et al., 1995). Already early villages exhibit a planned layout, and houses were built of mud bricks. Pottery appears in the Burj period, as well as a wide array of tools, domesticates, and first copper artifacts (Moulherat et al., 2002; Fuller, 2011). From 5000 BC, the occupation area, which was concentrated in Baluchistan, the Makran coast, and the western borderlands of the Indus, expand north- and westward into K.P., Gujarat and the Punjab plains (Gangal et al., 2010; Lemmen and Khan, 2012). Use of ornamental pottery and gold emerges, along with the manufacture of compartmented seals, glazed steatite, and beads. The use of weight indicates that trade was important for the pre-Harappan economy.

The first pre-Harappan cities appear as Mehrgarh, Amri, and Kotdiji before 3500 BC, they are built from mud (or sun-dried) brick. Many more villages than

cities continue to expand the cultural domain along the Ghaggar Hakra river and along the Makran coast with a doubling of sites numbers after 3200 BC (Law, 2007). Only in this Early phase do baked bricks appear at few sites, first at Kalibangan, Kotdiji, and Banawali (Chattopadhyaya, 1996).

At its peak, the mature IVC extended across the alluvial plains of Punjab and Sindh, Baluchistan, the Gujarat coast, and the surrounding valleys in Khyber Pukhtunkhwa (K. P.); in total, it encompassed a vast area of 1 million km² represented by thousands of individual sites (Fig. 1). Many large cities have been recognized, amongst them are the sites of Harappa and Mohenjodaro with approximately 40 000 inhabitants each (Mcintosh, 2007); total population is estimated at a few million (Lemmen and Khan, 2012). Its extensive and long-range trade network connected by sea to the Sumerian domain and the Arabian peninsula, it connected by land to the Bampur valley and across central Asia (Rao, 1965; Boivin and Fuller, 2009; Law, 2011).

After 1900 BC, the trade network collapsed and weights were disused; large cities were abandoned and baked brick manufacturing stopped; shell ornaments and seals were disused, and settlements moved eastwards into the Ganges valley (Possehl, 2002; Kenoyer, 1998; Datta, 2001). Sites in Gujarat seem to last longest, but by 1300 BC only few scattered sites remain of the IVC (Rao, 1963; Law, 2007; Mcintosh, 2007). The mystery and challenge in IVC scholarship lies in the unresolved causes for and diverse opinions about this decline; most popular theories include environmental change (e.g., Raikes, 1964; Meher-Homji, 1973; Staubwasser, 2003; MacDonald, 2011), river relocations (e.g., Wilhelmy, 1967; Giosan et al., 2012), or social causes (e.g., Wheeler, 1968; Kenoyer, 2005).

All of these theories, however, suffer from contrasting evidence, interpretation uncertainties, a temporal mismatch with the decline period, or have been reinterpreted to serve a particular political and historical view (Possehl, 2002; Guha, 2005). Most certainly, multiple factors contributed to the decline, including a breakdown of trade and religion (Kenoyer, 2005).

Table 1: Summary of local chronologies used in this study

Chronology	Period (BC)	Chronology	Period (BC)	Chronology	Period (BC)
Mehrgarh I	7000–5500	Early Harappan	3200–2600	Bara ¹³	1900–1300
Kili Ghul Moh.	7000–5000	Kulli (Early) ⁷	3200–2600	Jhukar	1900–1700
Northern Neolithic ¹¹	3200–1900	Kot Diji	3200–2600	Late Sorath	1900–1600
Mehrgarh II	5500–4800	Mehrgarh VI	3000–2800	Cemetery H	1900–1500
Burj Basket-Marked	5000–4300	Shahi Tump ¹	3500–3000	Rajaput	1900–1300
Mehrgarh III	4800–3500	Ahar-Banas ³	3000–1500	Late Harappan	1900–1300
Togau	4300–3800	Mehrgarh VIIC	2800–2600	Post-urban	1900–1300
Sheri Khan Tarakai	4300–3000	Dasht ¹²	2800–2200	Prabhas ¹⁰	1800–1500
Anarta ³	3500–2600	Kot Diji (Late)	2600–1900	Rangpur IIB ⁹	1800–1500
Hakra Wares	3800–3200	Kulli	2600–1900	Rangpur IIC ⁹	1800–1500
Kechi Beg	3800–3200	Accharwala ⁴	2600–1900	Pirak II	1800–1000
Pre-Harappan	3800–3200	Mature Harappan	2600–1900	Malwa	1700–300
Jodhpura ⁵	2600–1800	Uttarpradesh ¹¹	2600–1900	Swat Proto-Historic	1650–1300
Mehrgarh V	3250–3000	Ganeshwar ⁵	2600–1800	Lustrous Red Ware	1600–1300
Nal	3200–2800	Quetta ³	2500–1900	Complex B	1300–700
Anjira ¹	4300–3200	Sorath Harappan	2500–1900	Jhangar	1200–1000
Sothi-Siswal	3200–2600	Sorath	2500–1600	Iron Age	1200–1000
Amri-Nal	3200–2600	BMAC	2300–1700	Painted Gray Ware	1100–500
Ravi	3200–2600	Sorathor	2200–1800	Pirak III	1000–700
Damb Sadaat	3200–2600	Pre-Prabhas ¹⁰	2200–1800	Zangian	1000–200

Based on Possehl (2002) and Gangal et al. (2010), with changes from ¹Franke-Vogt (2008), ²Ratnagar (2000), ³Fuller (2006), ⁴Possehl (1999), ⁵Kenoyer (2006), ⁶Law (2007), ⁷Biagi (2011), ⁸Shinde et al. (2006), ⁹Meadow et al. (1997), ¹⁰Dhavalikar (1984), ¹¹Possehl (1990), ¹²Mortazavi (2011), and ¹³Shaffer (1981).

3. Data on bricks and urbanism

3.1. City and town size through time

The classification of settlements into villages, towns, and cities is not straightforward for the IVC, because of the unquantified contribution of pastoralist activities in between settlements (Possehl, 2002). An enclosing wall would classify a settlement as a city, a gated location with political power over the surrounding rural area and a central place for the exchange of traded goods (Kenoyer, 1998); a sufficient population size for division of labour and an economic and social organization allowing population growth characterize cities according to Childe (1950) and Modelski (2003). To a first degree, a settlement's area is a proxy for population size, and the ratio of its area of a settlement to the average settlement size an indication of its nodal position in a trade network.

For nine such nodal places, cities or towns, chronologically resolved size estimates are available. These are Mehrgarh, Amri, Kotdiji, Harappa, Mohenjodaro, Lothal, Dholavira, Kalibangan, Ganweriwala, and

Rakhigarhi (Tab. 2). We generated for each of these cities a continuous time series from the earliest to the latest area literature estimate. The thus calculated total urban area only includes are from those 9 cities whose temporal information is available. For example, some other large cities, like Tharowarodar, Nagoor, Nindowari, and Lakhueenjodaro have a combined area of ca. 200 ha during the Mature phase (Possehl, 2002).

3.2. Brick typology

Worldwide, mud bricks were first used in pre-Harappan time in Mehrgarh from 7000 BC, and baked brick technology appeared first in the IVC. The baked brick work is the signature mark of Harappan Bronze Age technologies. Most of the large cities of the IVC, i.e. Harappa, Mohenjodaro, Kot Diji, Ganweriwala, Rakhigarhi, and Lothal were built from both mud and baked brick (Tab. 3, with the largest baked brick:mud brick proportion at Mohenjodaro, Possehl 2002). Mud brick usage precedes baked brick usage, and continues when baked bricks are not used any more (Datta, 2001; Chattopadhyaya, 1996) Only one large city, Dholavira,

Table 2: Time-resolved data of the areal extent of 9 cities and towns.

City/Town	Area (ha) in period (year BC)
Mehrgarh ¹	30 ha 7000–5500; 16 ha 5500–4800; 9 ha 4800–3500; 9 ha 3500–3250; 18 ha 3250–3000
Ganweriwala ^{1,2,3}	79 ha 2600–2250; 81.5 ha 2250–1900; 80 ha 1900–1800
Kalibangan ¹	10 ha 2600–2250; 12 ha 2250–1900; 5 ha 1900–1300
Amri ⁴	10 ha 4300–3800; 30 ha 3800–3300; 20 ha 3300–3200
Lothal ^{1,5}	4.2 ha 2600–2250; 25 ha 2250–1900; 25 ha 1900–1700; 10 ha 1700–1300
Dholavira ⁶	2 ha 2600–2250; 30 ha 2550–2200; 80 ha 2200–2000; 100 ha 2000–1900; 70 ha 1900–1800; 15 ha 1650–1450
Harappa ^{1,6}	1 ha 3800–3200; 1.5 ha 3200–2800; 32 ha 2800–2600; 100 ha 2600–2200; 150 ha 2200–1900; 100 ha 1900–1800; 8 ha 1800–1500
Rakhigarhi ¹	2 ha 3200–2600; 0 ha 2600–1800; 80 ha 1800–1300
Mohenjodaro ^{1,6,7}	5 ha 2900–2600; 75 ha 2600–2250; 200 ha 2250–1900; 100 ha 1900–1700; 20 ha 1700–1300

References: ¹Possehl (2002), ²Law (2007), ³Agrawal (1993), ⁴Possehl (1990), ⁵Rao (1963), ⁶Kenoyer (1998), and ⁷Dani (1971)

is built completely from mud bricks (Bisht, 1982; Possehl, 2000).

Quite the opposite, most villages and towns in the IVC were built from stones and mud bricks (Datta, 2001; Chattopadhyaya, 1996). The few exceptions are Jalilpur, Kalibangan, and Chanhudaro, where also baked bricks were used (Mughal, 1970; Joshi et al., 1984; Flam, 1981). Chanhudaro stands out in this list, as there is no preceding mud-brick only phase for this site (Flam, 1981).

3.3. Spatiotemporal distribution of Harappan sites

We used the Indus Google Earth Gazetteer (version August 2008) compiled by Law (2007) for the geolocation of artifacts relating to the Indus valley. From this database of 3348 dates from 2125 distinct find sites, we use here the cultural attribution and location of those 3102 Neolithic and Bronze Age sites and dates that are in the spatial and temporal domain of our study. For the pre-Harappan phases, the Kili Ghul Muhammad, the Burj Basked-Marked, the Togau (and Sheri Khan Tarakai), and the Hakra/Kechi Beg (including Anarta complexes), we extracted 374, 421, 706, and 1039 dates, respectively. For the Harappan Early, Mature and Late phases, we obtained 1321, 1848, and 1085 dates, respectively (Fig. 2). To our knowledge, this gazetteer is the most extensive and the most representative data set of lithic and metal artifacts of the Indus valley tradition. It has been used to investigate the trade and distribution networks of the IVC by its author (Law, 2011).

4. Bricks and urbanism in IVC rise and decline

4.1. Bricks

Bricks constitute a large part of the archaeological material left behind by the Indus civilization. These bricks provide information on the number and spatial distribution of settlements, on the extent and density of settlements, and on the relation between dense urban and sparse rural areas. Even more, bricks inform about structural and symbolic functions in ancient societies (Kenoyer, 2006)

Brick work literally lays the foundations of the Indus Valley cultural tradition when it emerges in after 7000 BC. Its prominent role, however, is taken by baked bricks, which were manufactured only from the end of the Early to the beginning of the Late phase, a distinct and narrow 1500 year period within the almost six millennia of this tradition. Why this shift to and away from bricks? Baked bricks are a superior technology over sun-dried bricks, and while most of the building continued to be performed with mud bricks, baked bricks were extensively used where their improved strength was important (Possehl, 2002).

Baked bricks are less affected by long-term water exposure; this water resistance became a key factor in the expansion of Harappan villages and cities into the Punjab flood plains. Their sustained establishment in the flooding zones of the river plains was facilitated by baked brick technology. The protective function of baked bricks is exemplified by the massive and technically refined flood protection structures around Mohenjodaro and Harappa (Kenoyer, 1998). Baked

Table 3: Data on Harappan location where information on brick typology and usage time is available. Dates correspond to local stratigraphic chronology (Tab. 1).

Location	Mud brick	Baked brick	References
Harappa	3800–1300	2500–1800	Datta 2001; Chattopadhyaya 1996; Possehl 2002
Mohenjodaro	2900–1300	2600–1800	Datta 2001; Chattopadhyaya 1996
Kot Diji	3200–1300	2600–1800	Bisht 1982; Bhan 1975; Datta 2001; Chattopadhyaya 1996; Possehl 2002
Banawali	3200–1000	2600–1800	Bisht 1982; Bhan 1975; Datta 2001
Ganweriwala	2900–1800	2600–1900	Mughal 1997
Rakhigarhi	3200–1300	2200–1600	Nath 2001
Dholavira	3200–1450		Possehl 1979; Bisht 1982; Possehl 2002
Lothal	2600–1300	2500–1500	Rao 1979; Datta 2001
Mehargarh	7000–3800		Jarrige et al. 1995; Datta 2001; Possehl 2002
Kili Ghul Muhammad	6000–1800		Fairservis 1956; Datta 2001; Chattopadhyaya 1996
Sur Jangal	4300–3800		Fairservis 1959; Datta 2001
Rana Ghundai	4000–1800		Ross 1946; Stein 1929; Datta 2001; Chattopadhyaya 1996; Lamberg-Karlovsky 1972
Damb Sadat	3200–2600		de Cardi 1983; Datta 2001; Chattopadhyaya 1996
Mundigak	3300–1800		Ball and Gardin 1982; Datta 2001; Chattopadhyaya 1996
Amri	3200–1800		Flam 1981; Datta 2001; Chattopadhyaya 1996
Chanhudaro		2500–1700	Flam 1981; Majumdar 1934; Possehl 2002
Sanghol	1800–500		Bhan 1975; Joshi et al. 1984; Datta 2001
Bhagwanpura	2600–1500		Bhan and Shaffer 1978; Joshi et al. 1984; Datta 2001; Chattopadhyaya 1996
Nal Samadhi	3000–(2200) ¹		Rai and Kumar 1989; Chattopadhyaya 1996
Kalibangan	3200–1000	2600–1800	Thapar 1979; Joshi et al. 1984; Datta 2001; Possehl 2002
Jalilpur	3300–1500	2800–1800	Mughal 1970
Gumla	5000–3200		Dani 1971
Rehman Dheri	2900–1800		Dani 1971

¹Date estimated by authors.

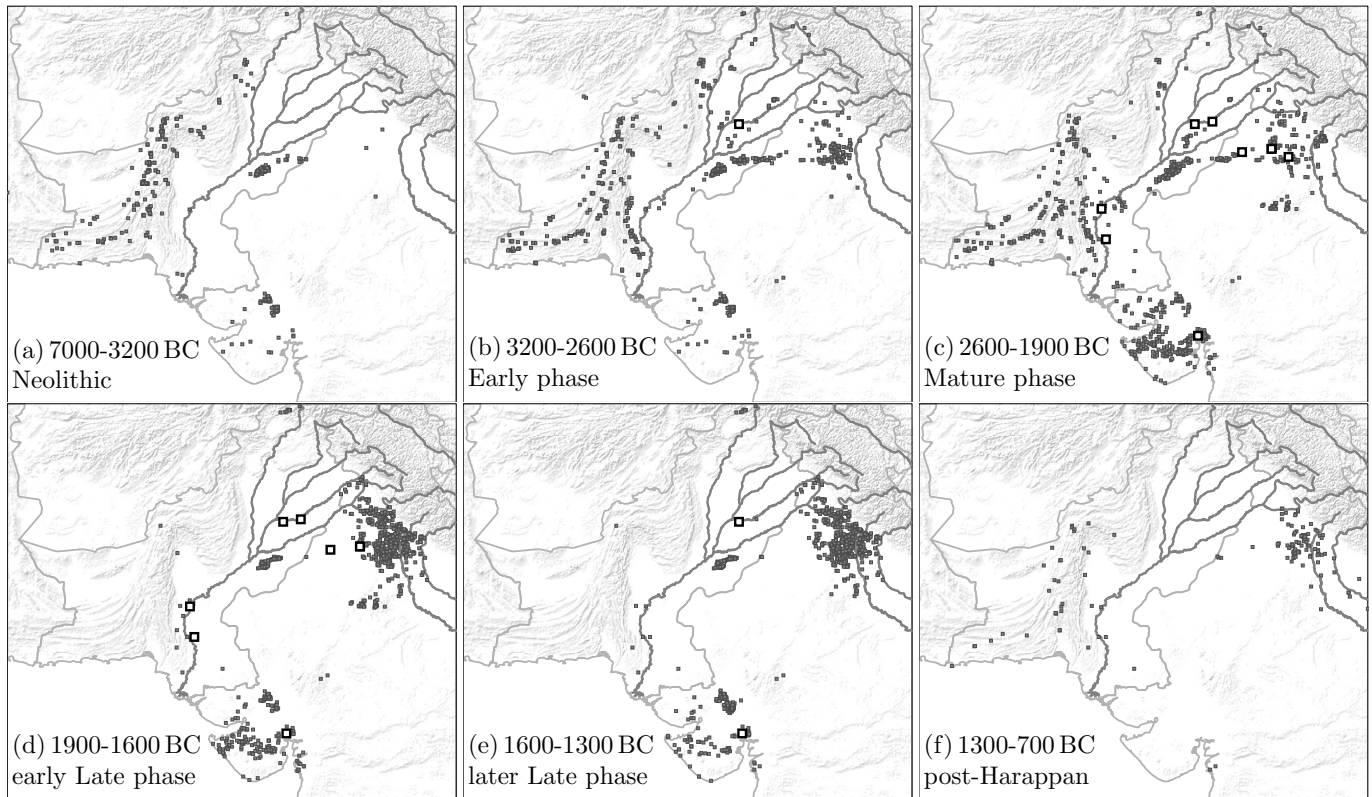


Figure 2: Spatial and temporal distribution of find sites of the Indus valley cultural tradition from Law (2007) with the chronology from Tab. 1. Sites with baked brick usage are highlighted with large square symbols.

brick usage for all buildings in the flood-prone city Chanhudaro demonstrates the importance of baked-brick technology for flood protection.

Not only for flood protection, but generally for urbanism baked bricks seem to have been a precondition: almost all large cities of the Mature phase (Dholavira, Chanhudaro, and Mohenjodaro being the exception) are built with a combination of sun-dried and baked bricks. Quite likely, their use as house foundations and for the lining of sewage systems was crucial for the sustained growth of villages in to large cities. Besides for protection from water, baked bricks were used for city walls and citadels in the four largest cities Mohenjodaro, Harappa, Ganweriwala, Rakhigarhi, and several minor cities and purpose sites (Smith, 2006).

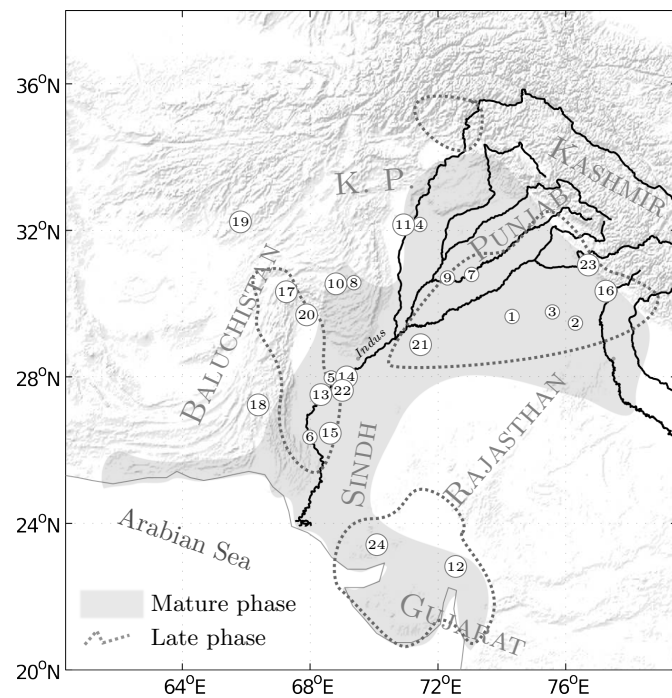


Figure 1: Spatial extent of the Indus Valley Culture in the Mature and Late phases with major urban centers and towns mentioned in the text: 1 Kalibangan, 2 Rakhigarhi, 3 Banawali, 4 Rehman Dheri, 5 Naru Waro Dharo, 6 Amri, 7 Harappa, 8 Rana Ghundai, 9 Jalilpur, 10 Sur Jangal, 11 Gumla, 12 Lothal, 13 Mohenjodaro, 14 Lakhueenjodaro, 15 Chanhudaro, 16 Bhagwanpura, 17 Damb Sadat, 18 Nindowari, 19 Mundigak, 20 Mehrgarh, 21 Ganweriwala, 22 Kot Diji, 23 Sanghol, and 24 Dholavira.

The temporal distribution of the number of cotemporal sites using bricks (from Tab. 3, shown in Fig. 3a) shows four different dynamic regimes of overall brick usage: (1) a steady and slow increase characterizes the Neolithic periods, (2) a sudden doubling and steep increase of brick sites is typical for the Early Harappan phase; this (3) levels out during the Mature phase before it is (4) reversed by a strong decrease during the Late and post-Harappan phases. Only during the Mature phase, most of the sites investigated use also baked bricks; and baked bricks decline entirely during the Late phase.

The baked brick technology, once invented, required skilled labor, standards, and natural resources. All these were available within the IVC during the Mature phase. There is no evidence for scarcity of natural resources for baked brick production. Fine silt (and water) abounded in the river plains of Punjab and Sindh. Irrespective of potential climatic changes, the gallery forests along the perennial rivers provided an ample and steady supply of fire wood: Meher-Homji (1973) estimated that only 200 hectares of riverine forest were required to supply baked bricks long enough to support the large city of Mohenjodaro (which was mostly built from baked bricks) for 100 years.

The second requirement—standards—has been a long-standing and featured trademark of Harappan masonry. Possehl (2002) calls the typical ratio of 4:2:1 (length to width to height) of Indus Valley bricks the “Indus proportion”. The adherence to this ratio was ensured by the use of standardized molds. While this ratio was typical at Harappa for large bricks, some cities, like Kalibangan, also used different brick ratios (3:2:1) (Mcintosh, 2007). During the Late phase, brick dimensions diverged away from the Indus proportion (Datta, 2001; Mcintosh, 2007).

Beyond the molds, the standards are also preserved in the craftsmen’s tradition and in social norms. The deviation from the standard in the Late phase could therefore point to a changed social norm, or to the lack of craftsmen to keep up the traditional brick manufacture. This third requirement of skilled labour refers to the craftsmanship and knowledge needed to choose the correct silts, mix the appropriate quantities of silts and water, and find the right temperature and roasting time to produce maximum strength bricks. Did craftsmen and their skills migrate? There is no direct evidence. The late appearance of bricks in the Gu-

jarat sites, predominantly Lothal after 2200 BC (Rao, 1965), however, could be evidence for increased need of brick producers in the south of the IVC, when at the same time the size of Harappa already started to decrease. Outside of the IVC baked brick technology appears in Susa (eastern Gulf of Persia), where they are used in monumental construction from 1800 BC (Gallet et al., 2006).

4.2. Urban center

The contrast between rural and urban lifestyle in the IVC is best portrayed by the distribution of find sites on the one hand, and by the area of the largest cities on the other hand (Fig. 3b). Between 5000 and 1300 BC, there is a continuous occupation of between 400 and 1000 cotermporal sites recorded in the Law (2007)'s database. The increase from pre-Harappan to the Early phase is around 300 sites, and another increase by 300 sites occurs from the Early to the Mature phase. The number of sites falls slowly to 800 during the Late phase: the Indus Valley decline cannot be detected in this dataset.

It is, however, not the number, but rather the spatial pattern of sites which changes through pre-Harappan (Lemmen and Khan, 2012) and IVC phases (Joshi et al., 1984; Gangal et al., 2010). At the end of the Mature phase, only along the Ghaggar-Hakra river sites disappear whereas new sites emerge in the upper Ganges reaches. By 1500 BC, most of the Baluchistan and Punjab sites have disappeared, while sites in Gujarat and along the Ganges are still present. The Gujarat complex disappears by 1000 BC (Gangal et al., 2010); these authors also note that during the terminal Mature phase many small sites replace large sites; they attribute this to a movement of population from urban centers into villages.

In contrast to the number of (small) sites, the data on large urban centers and their area (Tab. 2) exhibits strong variations. The combined urban area of large cities was below 40 ha until 2600 BC. The few pre-Harappan and early Harappan cities (e.g., Kalibangan, Amri Nal) were small, in contrast to the many and large cities of the Mature phase, where the largest cities were Mohenjodaro, Harappa, Ganweriwala, Dholavira, and Rakigarhi, each of them between 80 and 200 ha. Total urban area is 450 ha in the first half of the Mature phase, and increases by another

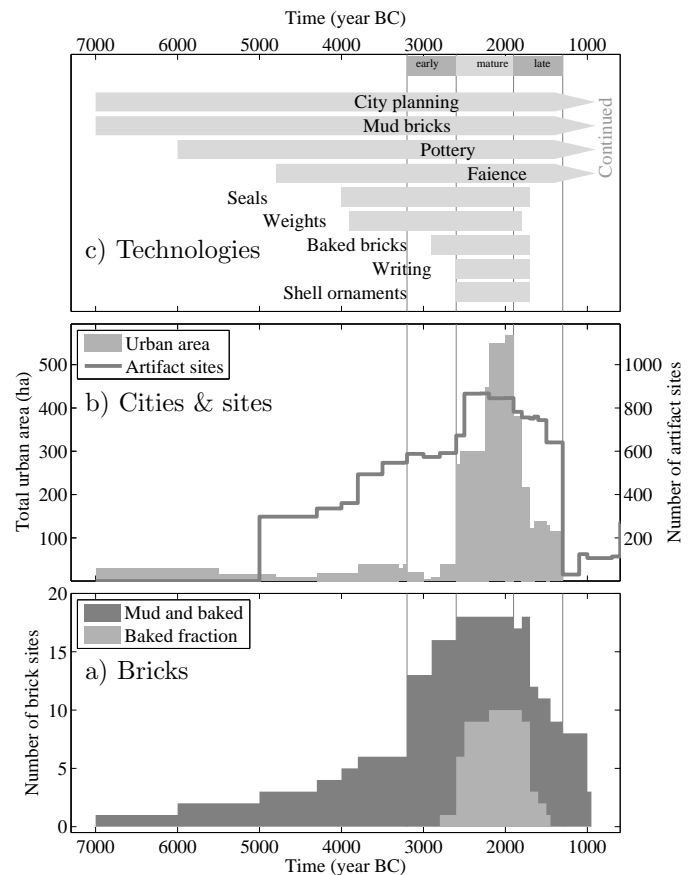


Figure 3: (c, bottom) Brick typology in IVC cities, shown as the number of sites employing mud bricks, or employing both mud and baked bricks (Tab. 3). (b, middle) The rural-urban contrast, shown as the total urban area (from Tab. 2) and the number of Indus artifact find sites from Law (2007). (c, top) Introduction, presence and expiration of key Harappan technologies (Kenoyer, 1998; Possehl, 2002). Arrows show a continuation of technology in successor cultures.

50% after 2300 BC.

From the Early to the Mature, and within the Mature phase, the growth in urban area by far exceeds the slow dynamics of the number of settlements. This discordance points to an intensification, a population growth within or movement towards the urban centers. Mirroring this intensification, the drastic decrease from 750 in the Mature to 100 ha urban area in the Late phase is not accompanied with a decrease of the site numbers: the IVC's population did not de-

Table 4: Simplified mirroring of key Harappan technologies in social relations

Technology		Social relation
Baked bricks	↔	skilled labour
Weights	↔	trade links
Seals	↔	moral authority
Writing	↔	administration
Shell ornaments	↔	elite status

crease, but rather moved from the cities into smaller (and many) villages

How is the brick dynamics reflected in the urban area? Both baked bricks and urban centers existed almost exclusively in the Mature phase, and both experienced a strong increase before and decrease afterwards, pointing to a strong correlation between these two aspects of urbanism. It is difficult—considering the temporal uncertainties and low number of sites considered—to establish a temporal sequence between the two. With the current data, the baked brick increase seems to lead the urbanization, which would confirm the role of baked bricks as a prerequisite for urban centers. The temporal uncertainty in the chronology, however, would need to be decreased for a better quantification of the phase relationship between baked bricks and urban area.

4.3. *Urban mind*

For the Harappan urban mind, baked brick technology represents one of the most important characteristics. With the baked-brick stimulated rise of urbanism, dense population were possible which stimulated innovation (Lemmen, 2012); Mature phase technologies like writing and shell ornaments flourished (Fig. 3c).

The IVC was centrally organized, an empire under common rule. Priestly elites seem to have exerted their power rather by moral authority than force; temples, palaces and evidence for warfare are absent from the archaeological record (Piggott, 1950; Ratnagar, 2000). The coherence provided by a moral authority may also be a decisive factor in ensuring the brick dimensions standard.

Harappa was also a closed society: Skull features from prehistoric cemeteries indicated that urban Harappans differed from surrounding villagers; apparently, social practice discouraged mixing with

people outside the city and promoted endogamy (Bartel, 1979)¹.

Skills, trade, authority, and elite status are social dimensions which can be mapped to the material culture (Tab. 4). For example, the symbolism that held together Harappan society is mirrored in its seals. Elite status is expressed by shell ornaments. The Indus script has not been deciphered, the existence of a writing system, however, points to use for accounting and administration. Thus, the decline in baked brick manufacturing is not merely a loss of one specific technology, but also represents a considerable loss of symbolism (Possehl, 2002).

5. Insights for the decline

Social disruptions at the beginning of the Late phase put an end to religion and trade. The changed burial pattern points to a different belief system; additional layers of glaze are used in distinctive pot burials, and glass making and bead drilling techniques were altered. Trade with the Swat region ceased and resulted in a decline of shell working. This has been interpreted as a disturbance of the elite structure (Ratnagar, 2000; Kenoyer, 2006; Nichols et al., 2008). Postcranial injuries on excavated skulls point to interpersonal violence among Harappan elites (Robbins Schug and Gray 2012, but not Mohenjodaran, Kennedy 1984), and some cities were (partly) burned, like Kotdiji, Gumla, Nausharo, or Amri (Possehl, 2002).

Could the environmental changes that have been put forward be responsible for the social upheavals? Aridity and river relocation seem credible for the Ghaggar Hakra area (Staubwasser, 2003; Giosan et al., 2012); floods occurred in cities in Sindh: a total of 5 m silt, composed of up to 2 m thick individual deposits in Mohenjodaro shows the consequence of inundations from the middle of the Mature to the end of the Late phase; multiple alternating cultural and silt deposit layers indicate rebuilding and renewed floods in this city (Raikes, 1964; Pruthi, 2004).

Even if one ignores the contrasting evidence, the interpretation uncertainties, and the temporal mismatches with the decline period of the suggested environmental factors, there seems to be no environ-

¹Even today, endogamy prevails in South Asian populations and preserves genetically distinct tribes (Chaubey et al., 2007)

mental reason that could explain the demise of urban centers and relocation of villages from Punjab and Baluchistan. Rather, social causes, like an internal political struggle, which lead to the visible change in the Harappan elite system (Kenoyer, 2005) should be investigated.

We propose that a changed elite structure would also explain the loss of urban coherence, the diverging brick standards, and the depopulation of cities. Moreover, a changed elite seemed to have not been able, or not to have been willing, to continue baked brick manufacturing and the maintenance of the flood protection structures in Punjab and Sindh, rendering their cities vulnerable to flooding at least from 1700 BC². If we take into account that elites were replaced by people originally from outside the IVC, their unfamiliarity with local environmental conditions and protection needs, or their different management priorities could have exacerbated the problem of neglected flood protection. Looking at the brick dynamics tells us about social dynamics.

6. Conclusion

We provide here a novel integrative view of IVC site distribution, its urban-rural contrast, and the dynamics of brick usage and urban size to find new points of departure for interpreting the IVC decline. We find that despite a large geographic change of the site distribution, the number of sites and—to first approximation—population does not change much between the Early, Mature, and Late phases. Urban area and baked bricks, however, change dramatically in the material culture, as do their social counterparts administration, elite structure, and religion. By concentrating on the cities, we point to primarily social reasons as a starting point for further investigations on the IVC decline.

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²Baked brick structure on average need to be replenished at 200 year intervals in the pertaining climate conditions.

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