RESOURCES OF THE OCEAN FRINGE AND THE ARCHAEOLOGY OF THE MEDIEVAL SWAHILI

Edward Pollard

It is accepted that the maritime environment underpinned Swahili economy and society. Not only was it central to the Indian Ocean trade that formed the basis of wealth and power, it is still reflected in the very fabric of the towns through their coral stone architecture (see Gensheimer, this volume). While that architecture is today the most visible legacy of Swahili society at its medieval peak, it represents just one element of a range of resources derived from the coastal hinterland environment that once supported the port cities. Here I review the archaeology of that maritime resource use. The investigation extends beyond the urban edge to some of the less explored, secluded parts of harbours and coastal fringe, including the intertidal zone. This area, with its rough terrain, impenetrable vegetation and absence of regular and organised transport, is nonetheless rewarding, as it reveals signs of the provision of sustenance, building and trade resources. It also was a location for industries that, for environmental and resource reasons, may have been conducted peripherally to the main settlements. Investigation of the coastal fringe complements studies of the towns and trading structures, and contributes to a more holistic view of activities and relationships in a society whose maritime heritage is so notable.

Resources: their historical and archaeological traces

The key maritime resources derive from an environment that varies between mangrove-rich creeks, estuaries and rias (drowned estuaries), sandy coasts formed from river deposition, and the raised coral limestone and coral reef coasts found on higher-energy exposed coasts. Fringing reefs on exposed coasts may be situated at the seaward end of a wave-cut platform, or enclose shallow lagoons at low tide. Substantial sediment deposition occurs near river mouths, providing sediment to form sand flats, spits and sandy lagoons often vegetated with seagrass. In sheltered areas such as creeks and estuaries, mangroves grow into dense forests between the neap high and low water marks, known as the eulittoral zone. Depending on the steepness of the beach gradient, there can also be wide unforested sediment flats below and above the eulittoral zone. On the landward margin, sand flats are often referred to locally as jangwani after the Swahili term for desert and a reference to the lack of vegetation.
This complex environment has traditionally provided numerous resources for human use. Those currently exploited include fish, salt, mangrove wood, coral, seaweed and coconuts, but these are evident, too, in the historical and archaeological record. The Classical document *Periplus of the Erythraean Sea* mentions coconut copra or oil and tortoise shell as exports. It describes turtles being caught from small sewn boats and a form of fish-trap basket (Allen 2005: 60). Coconut husk is traditionally used to make coir for rope or string, used in rigging, stitching vessel planks and binding fish traps. The husk is buried under sand and a covering of rocks in the intertidal zone for micro-organisms to break down the connective tissues so the fibres remain (Richmond 1997: 21). At Angoche, Mozambique, the husk is tied within a bundle of sticks or placed across streams in the soft mud among the mangroves, due to the lack of stones on these unconsolidated islands.

Some archaeological evidence for fishing activities derives from the site of Nkukutu in the Rufiji Delta, where grooves in sandstone are thought to result from smoothing and sharpening of the iron harpoons and hooks also found there (Chami and Mapunda 1998: 69). This was associated with Limbo tradition pottery dated from the last centuries BCE to about the third century CE (Chami 1998: 208). Common marine artefacts in late first- and early second-millennium ports such as Mpiji, Kaole, Unguja Ukuu and Kilwa Kisiwani on the Tanzanian coast (and further north at Manda and Shanga in the Lamu Archipelago, and south at Mahilaka on Madagascar) (Map 1, p. xxii), comprise iron and copper hooks, fishbone, lead net-sinkers or line weights (Chittick 1974: 439, 456, 1984: 207; Chami 1994: 53, 57; Horton 1996: 362, 367; Radimilahy 1998: 181–7; Juma 2004: 122, 129; Pollard 2008b: 177, 183–8). Wright (1984: 49, 51) noted that fishbone on ninth–tenth-century Comoros sites mostly came from fishing around coral reefs, using nets, hook and line, and spears. This is similar to twelfth–fourteenth-century Kizimkazi Dimbani on Unguja (Zanzibar Island), and Shanga, although some fish from the latter were associated with mangrove and estuarine environments (Horton 1996: 379–80; Van Neer 2001: 392–3). Shark and barracuda were also exploited at Shanga from the twelfth century, whereas dugong was exploited from c. the eighth–fourteenth centuries (Horton 1996: 386). Turtle and possibly crab were also recorded at Kizimkazi as forming part of the diet, while cowries had a more ornamental role or commercial value (Van Neer 2001: 386–7).

### Fishing ethnographies

Fishing techniques are often difficult to detect archaeologically due to the ephemeral nature of equipment formed from wood and cord. Nevertheless, historical references indicate the longevity of techniques that persist to the present day. Such traditional fishing methods in the intertidal zone include the use of fish-trap baskets, made of wooden strips lashed together in a hexagonal shape, up to 1.5 m in diameter (Richmond 1997: 24). Additionally, fish-trap fences are employed: made of stakes connected by wickerwork or a close arrangement of sticks tied together. They are mostly found on the seaward side of mangroves, trapping fish as the tide retreats. Maganbani near Kaole, and Kiswere to the south of Kilwa, show remains of old wooden fish-trap fences at the low water mark (LWM) of the sand flats. Fish-trap fences in these same locations can be seen in the nineteenth-century Admiralty chart (Figure 3.1).

Nets are also employed, varying according to the environment. Gill nets consist of a long sheet of netting weighted along the bottom edge and with floats along the top. On the fringing reef coast these are the most common form of fish netting, near the reef flat of a shallow lagoon where the lagoon drains down to the LWM. Other types are the *juya* and *kutanda dagaa* that are more used in sandy areas. The *juya* net is hauled in during low tide after leaving it for several hours at sea. *Kutanda dagaa* is the method where a net or cloth is dragged...
around at low tide. Women and children catch small fish on the reefs and beach along with shellfish and sea cucumbers at low tide, and men collect shellfish for bait (Prins 1965: 135). A different type of fish trap was recorded in the Mbeegani Estuary near Bwembweni where fish are trapped as the tide goes out of the Nyanza River by a dam built of estuarine sediments and sand bags (Figure 3.2).

In many respects small-scale fishing activities have changed little to the present time. Structures at traditional subsistence ports are rudimentary, consisting of huts of grass on wooden frames, providing shelter and storage of equipment at the high water mark (HWM). Along with small vessels including canoes, outrigger canoes and small dhows, material evidence can include wooden supports for boat building and repair, spare masts, hearths and shell middens. The smallest ports are often no more than temporary camps that store materials – nets, mangrove poles, fish-trap baskets, wicker frames for fish-trap fences wrapped in coils – above the HWM. Structural elements include huts and fish-drying racks. Traces are sometimes visible in archaeological investigation of the backshore in the form of post-holes (Pollard 2008a: 275), although the presumed use also of coconut frond mats, pliable mangrove sticks and coir rope is a limiting factor in survival.

Craft, construction and industrial resources

Fish-drying represents the most basic of processes in the treatment of marine resources. This is done in the present day on a mat or above the ground on a fish-drying rack in Tanzania, but drying of lipara (juvenile fish) on the bare sand and hanging large fish from a pole was observed in Angoche in Mozambique. Treatment of readily available materials in archaeological deposits includes shell-working that could have been for personal ornament but, similar to cowries, could
have been used for trade (Fleisher and LaViolette 2013: 1,159). Also, shell impressions can be used as decoration on pottery (Wright 1984: 25). Fishing artefacts are often found in association with seashells and, especially in the first millennium, ‘bead’ grinders and shell beads. The shell beads from Manda and Kaole Village include roughly fashioned, pierced and unpierced blanks indicating local manufacture (Chittick 1984: 183; Pollard 2008b: 187). Horton (1996: 323) recorded disc and tubular shell beads dating from 750–1100 CE, using in particular the gastropod *Anadara*. However, many of the shell beads identified from Kaole Village are Giant African Land Snail (*Achatina*), not marine shell (E. Wilmsen, personal communication). Chittick (1974: 473) says, although rare, shell beads continued to be made until the sixteenth century. ‘Bead’ grinders can be made of sandstone, *Porites* coral, river pebbles, quartz, coral limestone and local and imported pottery (Chittick 1974: 414–15; Horton 1996: 323). It is likely that these grinders were also used to produce rubbing sherds (small disks for various uses), spindle whorls and for polishing iron objects.

Apart from daily use in construction, the coastal wood resources of eastern Africa were a rich source of materials for both construction and trade (see Walshaw and Stoetzel, this volume). The ubiquitous coconut palm provided food, timber, alcohol (through sap fermentation), oil and rope (Dharani 2002: 288). Various woods such as the casuarina were indispensible for boat-building and repair of local and trading vessels. Above all, different types of mangrove wood satisfied demand for some dyes, medicines, fuel for cooking and burning in lime and iron production and, most importantly, termite-resistant wood for building (Table 3.1). Mangroves were recorded in eastern Africa during Classical times, as the *Periplus of the Erythraean Sea* refers to ‘the large laurel grove’ in Somalia; laurel and olive trees growing in salty water was the usual Greek description of mangroves around the Red Sea and Gulf. The uses mentioned at that time were for building huts, making musical instruments, food for cattle, and medicine (Schneider 2011). Historical sources indicate that mangrove poles were a major export from the east African coast to the Persian Gulf around the end of the first millennium AD (Trimingham 1975: 132). The twentieth-century traveller Alan Villiers (1940: 155) recorded that the dimensions of rooms in Arabia were dependent on the size of mangrove roofing poles cut in eastern Africa. Ibn Hawqal, a traveller and geographer of the tenth century, noted that merchant and ship owners’ residences of Sīrāf were built with *sāj* (teakwood) and other woods from eastern Africa (Hourani 1995: 70; Insoll 2005: 353), while Ibn Battuta in 1331 described Kilwa as built of wood with the houses roofed with reeds (Chittick 1974: 246).

Another indispensable resource, sea salt – particularly important for cooking and perhaps fish preservation – is presently produced from salt pans in *jangwani* areas of the intertidal zone in the Kilwa and Bagamoyo areas. Saltpan walls are made from sand to enclose rectangular areas connected by sluices and canals, flooded during spring high-tides in the dry season. Small-scale salt production comprises boiling brackish water in clay bowls, fuelled by large amounts of mangrove and neighbouring trees. With seven tonnes of wood needed to produce one tonne of salt this method is inevitably destructive of the environment (Muhando et al. 2001: 57; Taylor et al. 2003: 7). Chittick (1975: 151) observed circular pans in use near Winde, north of Mkadini in the Bagamoyo area. In the surrounding areas he identified ninth–tenth-century Sasanian-Islamic Ware around a low mound, as well as twelfth–thirteenth-century pottery along the creek that he interpreted to be from ancient salt working. He further observed pottery scatters analogous to those at Mkadini, on the creek edge adjacent to the site of Bui, near the south-west corner of Pate Island and adjacent to the creek at Kilwa (ibid.). Changwehela, located roughly 23 km south of Bagamoyo (Map 1, p. xxii) (Chami 1994: 54–5), was another likely site where salt extraction was important. Salt works around the estuaries at Kaole and Mkadini in the medieval period have also been noted by Kleppe (in Lane 2005), in connection with a possible fish-salt trade between Kizimkazi Dimbani (on Unguja) and Kunduchi and Bagamoyo on the mainland.
Coral limestone is, of course, the defining element of stonetowns, having been used as a building material at Swahili sites since the tenth to eleventh centuries. Both limestone and its lime-based derivatives complement mangrove wood in supplying the construction industry’s basic needs. The primary blockwork of building uses the limestone, often referred to as coral rag, obtaining it from wave-cut platforms and cliffs. In addition, unfossilised coral is gathered by being prised off the seabed at low tide and piled on the reef for later collection (Richmond 1997: 21). The fine-grained *Porites lutea* is carved and shaped, often while still soft and wet, for use in more intricate and decorative building work (LaViolette 1996: 76; Richmond 1997: 144). Apart from its construction use, limestone and reef coral were also employed as a flux in iron production. It occurs at Bwembweni in connection with iron-making dating to tenth–thirteenth centuries (Ichumbaki and Pollard 2015). It is likely that the initial iron smelting from ore was undertaken outside the urban area as in Bwembweni, which is situated away from the medieval settlement of Kaole (Figure 3.2).

**Table 3.1** Mangrove species along the eastern African coast

<table>
<thead>
<tr>
<th>Species</th>
<th>Characteristics</th>
<th>Habitat</th>
<th>Direct maritime uses</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Avicennia marina</em> (White mangrove)</td>
<td>Horizontal roots radiate from trunk base, pencil-like aerial roots develop from these.</td>
<td>High range of salinity; compact substrate; sand flats; newly deposited sediments; margins, middle and seaward side of mangrove forest.</td>
<td>Fuel for cooking, fish smoking, production of lime, boat building – dugout canoes, dhow ribs.</td>
</tr>
<tr>
<td><em>Bruguiera gymnorrhiza</em> (Black mangrove)</td>
<td>Base buttresses by prop roots and knee-like pneumatophores.</td>
<td>Well-developed mangrove forests, frequently in the deeper reaches of the muddy flats.</td>
<td>Red, very hard, termite-resistant wood; fish smoking, building poles, fishing stakes.</td>
</tr>
<tr>
<td><em>Ceriops tagal</em> (Yellow mangrove)</td>
<td>Stilt roots resembling five fingers closed together.</td>
<td>Marginal habitats near bare, saline areas; mainly confined to coastal mud flats.</td>
<td>Termite resistant; fuel, building poles, fishing stakes and fence posts.</td>
</tr>
<tr>
<td><em>Heritiera littoralis</em></td>
<td>Shallow roots rise horizontally from base of trunk.</td>
<td>Low salinity around river mouths.</td>
<td>Good firewood, boat building timber, dhow masts.</td>
</tr>
<tr>
<td><em>Lumnitzera racemosa</em></td>
<td>Small tree, bushy with small thin branches (red when young).</td>
<td>Low salinity and sandy soils.</td>
<td>Building poles and fuel.</td>
</tr>
<tr>
<td><em>Rhizophora mucronata</em> (Red mangrove)</td>
<td>Aerial prop roots like stilts, exclusive stands.</td>
<td>Muddy soils.</td>
<td>Good firewood; building poles exported to Middle East, fence posts, fish trap baskets.</td>
</tr>
<tr>
<td><em>Sonneratia alba</em></td>
<td>Peg roots, round canopy.</td>
<td>Salinity close to seawater.</td>
<td>Inferior firewood, boat building and general carpentry, pneumatophores used as fish net floats; fruit edible.</td>
</tr>
<tr>
<td><em>Xylocarpus granatum</em></td>
<td>Shallow ribbon-like horizontal root system.</td>
<td>Riverine areas, raised areas with flooding a few times a month.</td>
<td>Termite resistant; fuel, fish smoking, building boats, carts, dhow masts.</td>
</tr>
</tbody>
</table>

Lime-making, too, is generally an extra-urban activity, one frequently carried out on the littoral fringe at the raw material source, where carbon dioxide gas emitted in the production process and slaked lime are not conducive to the urban environment. Lime-making is still carried on today despite the dereliction of both Songo Mnara and Kilwa. Production takes place above the HWM, burning the limestone (either reef coral or coral rag) in a kiln, or more simply on stacked...
timber, for use in mortar, plaster, whitewash or white pigment (Figure 3.3). The latter technique mirrors an ancient tradition in the Kilwa area; Hans Mayr in the sixteenth century described the lime-making process whereby: ‘large logs of wood are piled in a circle and inside them coral limestone is placed; then the wood is burnt’ (Freeman-Grenville 1962: 107). This method is ongoing in the Kilwa area today, though shellfish may substitute for coral on sandier coasts.

Indications of an important lime industry, along Kilwa Kisiwani’s east coast in the medieval period, derive from substantial collections of reef coral and evidence of lime-making discovered in excavations on Mvinje Island and Msangamla Bay (Pollard 2008a: 274–5) (Figure 3.4). Undecorated pottery, fishbone, animal bone and shellfish within the same context at Mvinje Island Cave, and pottery found among reef materials at Kilwa, all dated to the fourteenth–sixteenth century, suggest exploitation of these resources during Kilwa’s prosperous phase (ibid.).

At Kilwa Kisiwani, Chittick’s (1974: 39–40) excavations exposed twelfth-century lime kilns, and comparable pits have been located at Songo Mnara (Fleisher and Wynne-Jones 2012: 193–4). Chittick (1974: 39–40) described an alternative and earlier method of lime-making which, despite the strictures noted above concerning production in an urban area, was conducted beside the Great House itself rather than externally. His trench contained lime kilns from a period when stone buildings were first introduced to the area. Feeder-trenches led into the kilns, with blocking stones placed to shut off the draught after the required temperature was obtained. The kiln floor had a deposit of lime from which carbonised logs projected radially

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Figure 3.4 Kilwa ria showing places mentioned in the text
from the edges. There continues to be present-day evidence for lime-making around Kilwa Kisiwani and Sangarungu Harbours and their sea approaches, especially outside settlements on Sanye ya Kati, Sangarungu Island and Songo Mnara, all easily accessible by boat.

**Foreshore industrial islets**

Resource exploitation and past industrial activity may well leave evidence in midden-type deposits located away from principal areas of settlement. Discovery of such often requires careful searching of the littoral fringe in none too accessible areas, but within the vicinity of ports that once contained population centres. A number of such mounds have been found on the shores of the rias and estuaries of medieval harbours. Their contents consist predominantly of pottery and often show evidence of fishing, iron working and mortar making. They may also have sometimes been associated with salt working or mangrove exploitation, lying as they do in shallow *jangwani* and mangrove forest areas.

At their most basic, middens developed in association with fishing at landing places on spits or small islands in the mangrove zone, in a manner similar to that recorded by Chittick (1975) at Mkadini. Pottery from excavation into such landing areas away from the primary trading port within Kilwa Kisiwani Harbour reveals utilisation concentrated during the twelfth to fourteenth centuries. The deposits contain not only fishermen’s midden material, but also animal and bird bone in similar quantities to fishbone, indicating the diversity of activity in the area (Pollard 2008a: 271). Evidence also of wooden structures in the form of stake holes, pottery and charcoal show the likelihood of a simple fishermen’s shelters, boat repair or fish-drying racks similar to those found today on the spit. Such contemporary fishing ports likely provided support to major trading settlements like Kilwa Kisiwani. Some of these ports also engaged in agricultural activities, determined from animal bone, fishbone and shellfish evidence (ibid.: 272).

The Mugongo area, on the mainland coast west of Kilwa Kisiwani, provides evidence of further middens that pottery evidence dates to the fourteenth–sixteenth centuries. They differ from previous examples in that they contain a large proportion of mangrove whelk in addition to substantial amounts of local pottery, animal bone and reef coral. The mounds, the largest of which is at Rwayo, are situated in a similar environmental location – on a sand spit at the border of *jangwani* – near modern salt works and mangroves. The site is near a channel through the mangroves and would have had easy boat transport with Kilwa Kisiwani. The large-scale exploitation of mangrove species may be a result of felling the mangroves in this area for trade and/or burning in salt production, while the whelk shells could derive from their stripping from mangrove prior to transport, and as detritus from consumption by workers. Another midden resulting from mangrove exploitation is at Kaole Ruins, located on a large sand spit, which has dense mangroves today on its northern side. An excavation here, near the HWM, also revealed a dense mangrove whelk midden along with hooded oyster which grows on the roots and branches of mangroves, in contexts dated to the thirteenth to sixteenth centuries (Pollard 2008b: 170–3).

Other harbours in the Kilwa area provide evidence of external operations in support of village activity. For example, Kiswere Village, situated at the mouth of a river flowing into Kiswere Harbour, is situated c. 45 km south of Kilwa. It was possibly a provisioning port on the sailing route between Kilwa and Sofala (Pollard and Ichumbaki 2016). Two sandy islands named Ombo Kisiwani rise about 1 m above HWM in the delta mangroves. They measure approximately 20 by 10 m, though are surrounded by a larger area of *jangwani*. Large ‘water’ pots are eroding out of the banks of the islands onto the *jangwani*, and the highest parts of the islands display further large pot fragments. The pottery dates to the late twelfth–thirteenth centuries and exhibits peeled surfaces probably from salt corrosion. Sandstone is also found among
the pottery and may have been used as a temper. A clearly defined layer of mortar implies the multiple uses of at least one pot, probably for mixing, transport or mortar application. Ridges and depressions on the pot’s internal surface indicate that fingers were used to scoop out the contents (Ichumbaki and Pollard 2015). Lime coating on pot fragments could be interpreted as making vessels more watertight, perhaps for storage or transport. Their location close to a stream draining a mangrove forest suggests that the pot could be used for carrying water from this freshwater site. In addition, mortar layers on other pots suggest mortar was being made here, again using some saline-free water and prior to transport to settlements in the bay or to trading vessels.

A broader range of industrial activity is suggested by the site of Bwembweni Mounds, whose location 1.1 km upstream suggests an association with the important thirteenth–sixteenth settlement of Kaole Ruins in the Mbegani Delta. The mounds show similarities with Ombo Kisiwani but are more substantial, and are a potential site of significant industrial activity associated with the more important settlements in the area. The site was discovered by pottery eroding out of one of five artificial mounds onto the surrounding mangrove swamp and jangwani (Pollard 2008b: 164–7). Areas differed from c. 30–50 m in diameter and 2–5 m in height. Excavation revealed large vessels with neck restrictions, thinning to the rim and limited decoration of rough incisions, red burnishing and neck punctuation dating to the tenth–thirteenth centuries. As at Ombo Kisiwani, finds at Bwembweni included sandstone, mangrove whelk and other shells, and pot fragments exhibiting splitting on both outer and inner surfaces due to salt corrosion. Some pots had mortar attaching usually to the inside surface, again implying use for mixing and/or transport.

Industrial activity was taken further at Bwembweni through iron production. A smelting furnace consisting of a horseshoe-shaped crucible associated with stake holes and postholes was recorded in one excavation (Pollard 2008b: 177). Orange staining of the surrounding soil provided further evidence of iron. Lime in the immediate vicinity might be associated with flux for use in ore smelting. Regrettably, Bwembweni has been subject to only limited excavation, but its extent, and volume and range of material, points to extensive industrial activity on the water margin at a distance from the main Kaole settlements (Figure 3.2 above).

It is to be expected that the economy of other once important settlements would have likewise encompassed industrial activity similarly located on the backshore. One such prospect for investigation is Mida Creek in Kenya, an area associated with the settlements of Gedi and Malindi (Figure 3.5). A preliminary exploration has identified Vigaeni Mound located, like Bwembweni Mounds, within mangroves about 50 m from the head of a channel. Vigaeni Mound is a midden composed of late medieval pottery, currently used as a fishing camp. Although possibly a waste dump, it shows organisation and management of industry and/or local trade goods by an administrative authority in the creek. Surface artefacts included reef coral, iron (probably anchor) chain, undecorated red pottery similar to that found at Gedi dated to the twelfth–sixteenth century (Kirkman 1954: 77), and a perforated pot fragment perhaps for rope making (Horton 1996: 342). Two rim sherds had rounded plain rims. Undecorated pottery can be difficult to identify but Horton (1996: 266) records less decoration on pottery at Shanga in the Lamu Archipelago from c. 1300 CE and this would correspond to surrounding late medieval ports in the creek.

As yet it is unexcavated, but it is located c. 2 km from the closest medieval stonetown of Kilepwe. It is within 100 m of a creek channel and would have been approachable only at the highest tides, unless sedimentation has grown much worse in recent centuries. More survey is needed, but such a large mound of pottery indicates industrial activity and the organised collection of broken pots into one location. Mida Creek, like the other examples, confirms the presence of potentially valuable archaeological material, but equally highlights the paucity of survey and excavation in the coastal fringe.
Maritime architecture

Investment in permanent structures outside the medieval stonetowns is shown by isolated stone-built mosques and tombs. For instance, on the east coast of Kilwa Kisiwani and Songo Mnara, there are at least three fourteenth-century mosques in the area of Mvinje and Kipakoni, as well as two panel tombs at Mkuje from the fourteenth–fifteenth centuries. No major settlements are located on this part of the coast, but the modern villages of Msangamla, Mikadi and Mkuje continue a tradition of lime-making and fishing, the villagers often making use of a series of stone causeways to cross the lagoon to the reef flat, allowing them to avoid areas of cone shells, sea urchins and moray eels in the lagoon and sharp coral bedrock of the reef crest.

The causeways themselves are, at least in part, of cultural origin. They are formed of reef-coral block and rubble, and originate on the shoreward side of the lagoon, extending seawards perpendicular to the coast to a maximum length of 250 m and breadth of c. 12 m (Pollard 2008c: 102–4). They terminate on the reef crest with a rounded platform up to 65 m across. Satellite images show the causeways to be found along the coast from Kilwa to Lindi, a distance of 120 km. They have encouraged the growth of mangroves, making them observable at high tide.

The regularity of their structure, and their value as guides for ships avoiding the reef and accessing the harbours for which they mark the entrance, encourage the view that they were built with navigation in mind (Pollard 2008c). Although centuries of wave action have altered their form, smoothing and grading their margins, limited evidence remains of a block-built structure. There are also many instances where reef coral has been modified as, for example, the landing place at Chani at the northern entrance to Sangarungu Harbour, where a mangrove-lined causeway forms a boat passage to a reef-coral beach. Another is a feature at Lukila Island on the northern entrance to Kilwa Kisiwani Harbour, which appears to have been raised for navigational purposes (Pollard 2011: 465–7). Further reef-coral walkways occur within the harbour, where they could not be natural, including a pier leading to the steps at

Despite evidence of stone construction on the shoreline, it is impossible to be definitive about the causeways’ origins. No comprehensive examination of the c. 130 structures between Kilwa and Lindi has been conducted, nor a geological/geomorphological study of any of the causeways undertaken. From a geological perspective, warping or faulting might be postulated in a region subject to ongoing tectonic activity associated with the eastern branch of the East African Rift System (Nicholas et al. 2007). However, most faulting in the region has a northerly component (Reuter et al. 2010), whereas the broad orientation of the causeways is east–west. Geomorphologically, some gravel ridge features similar in shape to the causeways, i.e. a tongue of land with a terminal platform, have been described at Taveuni Island, Fiji (Etienne and Terry 2012: 61–4). They are thought to be produced during tropical cyclones followed by wave diffraction to produce the shore-normal features. However, the area north of Lindi is nearer the equator than Taveuni and less subject to tropical cyclone activity, whereas much more energy would be required to move the greater volume of material associated with these eastern African features. It is noteworthy that the Taveuni ridges show a decrease in sediment size from the seaward edge of the tongues towards shore, a characteristic not repeated in the Kilwa causeways.

It is thus the absence of evidence to support an environmental mechanism, but the converse presence of building work on some causeway features, combined with a plausible rationale for their use as an aid to shipping, that a human role in their construction or modification offers a plausible explanation. The amount of labour required for their construction, particularly if entirely artificial, would have been formidable, but could be considered justifiable and affordable to safeguard valuable trade, especially gold trade between Sofala and Kilwa in its heyday. Not only did Kilwa control that trade, but the sultan, aristocratic families (ungwana), and traders received tribute, taxes and incomes from communities including Mozambique, Angoche, Sofala and Mafia (Freeman-Grenville 1962: 127–9; Kusimba 1999). Profits from agricultural investment and exchange permitted expansion of public buildings like the Great Mosque and construction of Husuni Kubwa Palace, as well as private residential expansion of coral-built housing (Prestholdt 1998: 13, 23). This flowering of the urban economy from the thirteenth century, particularly into the fourteenth and fifteenth centuries, reflects the income generated and funds available for public and private investment of all kinds. Certainly there would have been justification for coastal construction around Kilwa’s harbour and other ports to support and protect that trade upon which the city’s wealth depended.

The causeways on the east coast of Kilwa Kisiwani and Songo Mnara may be linked to the fourteenth-century mosques in the Mvinje/Kipakoni area, and the panel tombs at Mkuje, all substantial structures from the time when causeway use and coastal resource exploitation would have been at their height. The modern villages of Msanganla, Mikadi and Mkuje continue the traditions of fishing and lime-making, with Mkuye and Mikadi villagers using the causeways to cross the lagoon. This association with causeways is repeated further south at the small ports of Mitimiru and Kibungwi, which date from around the thirteenth century and relate to the approaches to Kiswere and Mto Mbanja Harbours (Figure 3.6). Pottery from thirteenth–sixteenth-century date and a continuing fishing tradition indicate long-standing exploitation of the marine ecology.

It is possible that members of the elite once had fishing, mangrove and lime-making rights over the foreshore, causeways and platforms. Some platforms that have been raised above the HWM at Songo Mnara have names suggesting ownership, such as Jomalambwana (‘the master’s stone’), Jomalakasim (‘Kasim’s stone’) and Funguyabintimwenye (‘the owner’s daughter’s reef’).
(Pollard et al. 2012: 59), although the dates to which these names apply are long lost. Some causeways, platforms and other marine structures such as islets are presently being exploited for lime, but continuity in use is displayed by old heaps of coral now soil-covered and middens deposits of bone and pottery among the reef coral. Locations such as Mvinje Island and Msangamla Bay show definitive evidence of coral collection for lime-making or stone storage prior to onward transport to the market, most likely in Kilwa or Songo Mnara.

**Transport of resources**

Overland routes between coastal points of production for much of the lime, limestone, coral, fish, salt and mangrove wood, and their places of consumption or transhipment, would have consisted only of tidal paths and cleared paths through dense scrub. Transport of heavy bulk items would have been by sea. The harbours and surrounding Indian Ocean coasts would have been busy with the movement of dugout canoes (mtumbwi, hori), double out-rigger canoes (ngalawa), and inshore dhows (mashua) to gather resources at the main landing places. The industrial islets of Bwembweni, Ombo Kisiwani, Vigaeni and Rwayo are all within 50 m of channels draining the mangroves, so capable of being visited by canoes and perhaps mashua (with their 8–12 m length and 0.6 m draught) at high tide. As streams and swamps are liable to geomorphological changes due to erosion and silting, the channels may have been closer in medieval times.

In general, canoes and sailing vessels of mashua size can cross the reef on Indian Ocean approaches to the harbours around Kilwa at high tide, and do so today to collect produce from shoreline villages to take to market. The modern lime kilns on the foreshore are set up in areas where a boat can land and remove the product. It would not be surprising that, during the period of peak prosperity, lime-making from the Kilwa-Lindi coast contributed to the building industry for large areas of the Swahili coast, due to the relatively easy availability of resources, particularly reef coral, compared with mouths of the major rivers such as the Rufiji and Ruvu,
where sediment impedes coral growth. Moreover, Mafia and Zanzibar show no evidence of major settlement along their eastern fringing reef coasts as a base for exploitation of the reef coral. Much further south lies the walled island of Somana, another fringing reef site, described by Duarte (Map 1, p. xxii) (1993: 62–5) to have been inhabited from the twelfth–fifteenth century. We may surmise that Somana exploited reef coral to provide valuable building materials for more southerly settlements such as Angoche, which lacks similar resources.

Littoral studies

All in all, the littoral margins and their resources prove to be a zone of rich potential for study, contributing to our understanding of the maritime heritage of the Swahili coast. As Lane (2005: 96) has pointed out, the full nature of that heritage, its origins and patterns of continuity and change remain poorly understood, largely due to the dominance of land-based paradigms as opposed to truly maritime approaches to the evidence. Investigation of the resources of the reef and intertidal zone, together with research on the backshore, plays an integral part in comprehending the workings of a society dependent upon its maritime location. Much evidence is fairly commonplace, such as the day-to-day work of the fishermen and lime-makers, but these are central to the running of urban settlements. The discovery of the causeways and their intriguing possible relationship with coastal navigation adds a more unexpected element to the medieval maritime scene.

The ephemeral nature of the wooden and cord materials used in fishing and boat construction requires modern ethnographic analogy and the study of historical records. More concerning, archaeological study of the shoreline suffers from the specific threat of coastal change through marine erosion and siltation processes, and more widespread processes of sub-aerial erosion, all of which place urgency on the work required. Much more remains to be discovered, not only by more study of the coastal margins and intertidal zone, but also the sub-tidal zone that, particularly around the harbours, must be a repository of wrecks, lost cargo and other artefacts of Swahili maritime economy. Such investigation has hardly begun.

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